Begotten in the splendor and flame of the summer sky, born with shuddering in the gloom of the hive, bees and men come much alike by life, the bees no less magnificently out of dust, no more abjectly from the spheres. Lower in scale of being, possibly, than human life, bee life, nevertheless, has not only developed a perfect political organization, but founded it upon an equally perfect society division of labor, divorceless marriage, obedient children, and a method of birth control that would absolutely insure the war resorting human race against its certain suicide.

From the book, "The Spirit of the Hive,"

by Dallas Lore Sharp.

Published by Harper & Bros., N. Y.

The ABC and XYZ
OF
BEE CULTURE

By A. I. and E. R. ROOT

A Cyclopedia of Everything Pertaining to the care of the Honeybee: Bees, Hives, Honey, Selling Honey, Implements, etc. Facts Gleaned from the Experience of Thousands of Beekeepers, and Afterward Verified by the Authors

THE A. I. ROOT COMPANY
MEDINA, OHIO
1935

225th Thousand

Printed in U. S. A.

To the throng of eager questioning brothers and sisters in the art of bee culture, in our own and other countries, this work is especially dedicated.

THE AUTHORS.

1877 Preface

In preparing this work I have been much indebted to the books of Langstroth, Moses Quinby, Prof. A. J. Cook, and some others, as well as to all of the bee journals, but, more than to all these, have I been indebted to the thousands of friends scattered far and wide who have so kindly furnished the fullest particulars in regard to all the new improvements as they have come up in our beloved branch of rural industry. Those who questioned me so much a few years ago are now repaying by giving me such long kind letters in answer to any inquiry I may happen to make that I often feel ashamed to think what meager answers I have been obliged to give them under similar circumstances. A great part of this A B C book is really the work of the people; and the task that devolves on me is to collect, condense, verify, and utilize what has been scattered through thousands of letters for years past. My own apiary has been greatly devoted to testing carefully each new device, invention, or process as it came up. The task has been a very pleasant one, and if the perusal of the following pages affords you as much pleasure I shall feel amply repaid.

November, 1877. A. I. ROOT.

Preface to the 1923 Edition

Little did A. I. Root, when he wrote the preface to the 1877 edition, realize that his modest work of 200 pages, written expressly for beginners, would develop during the following 45 years into the A B C and X Y Z of Bee Culture, a work which meets the needs of both beginners and professional beekeepers. Since 1877 great changes have taken place in the bee world. Then beekeeping was hardly recognized as a business, but today it has grown to enormous proportions, as is shown in the Foreword following. Thousands of colonies are now handled by individuals and syndicates, and honey is shipped by the carload to various parts of the world—an achievement which would not have been believed possible when the first edition of this book was published. Not only has this industry taken a great stride in a commercial way, but thousands of people are keeping a few hives of bees on their farms and back lots. They have discovered that bee culture is not only a pleasurable pastime, but an important source of income, since both honey and more and better fruit are secured. (See **Fruit Blossoms** in the body of this work.)

After the third edition, failing health, the cares of a rapidly growing business in the manufacture of beekeepers' supplies and the publication of Gleanings in Bee Culture, made it impossible for A. I. Root to keep pace with all the developments of beekeeping so as to make the necessary revisions. An assistant was required; and this position was naturally taken by Mr. Root's elder son, the present author and reviser, who had been his father's chief helper in the apiary and who had for many years been in constant touch with his experimental work with bees. At the same time that the junior editor rewrote the A B C of Bee Culture, he also became assistant editor of Gleanings in Bee Culture, and later, editor—a position he has held for thirty-five years. While the earlier editions of the A B C of Bee Culture described correctly the methods of beekeeping in northern Ohio and in other portions of the North where the climate and honey flora are similar, it soon became evident, as the result of an extensive correspondence, that conditions in other parts of the United States, where climate and soil are radically different, required a modified treatment.

In 1890, after some nine editions of this work had been published, it became apparent that it was very desirable that the new editor and author should make extensive

trips among the beekeepers of the different states. The first trip was made in 1890. Other trips followed in rapid succession, continuing up to the present time, reports on which have been given in Gleanings in Bee Culture. The data gathered during the first few trips showed conclusively the importance of adapting the teachings to the locality; and numerous changes and additions were incorporated, giving the experience of the most successful beekeepers in every state in the union. But in all cases the old matter originally written by A. I. Root has been retained so far as possible. So extensive have been the additions that the original work of 200 pages has expanded into the present volume of nearly 1000 pages.

The discriminating reader may discover in the treatment of the various articles apparent repetitions of what has been said elsewhere under other heads. Where this occurs, it is for a purpose. The restatement of a certain proposition from a different angle necessarily clears up a subject that might otherwise be misunderstood. For example, it will be found that the treatment of Windbreaks under Apiaries and under Wintering Outdoors, while similar, is enough different to require a special restatement under each heading. Again, in so complex a subject as the management of bees the reiteration of the same facts in a different form, as well as from a different angle, helps to make plain to the beginner a matter that he should not and must not misunderstand, if he would succeed. How to open a hive of bees is considered under the heads of A B C of Beekeeping, Anger of Bees, Manipulation of Colonies, Robbing, and Stings. Under the general head of Swarming there will be found the subhead, The Cause of Swarming, and likewise the subhead, Prevention of Swarming. There is some material under both heads that is similar. Knowing the cause, one would naturally apply the remedy; but in explaining the remedy it is important that many details in connection with the cause be stated.

As did A. I. Root in his modest preface of 1877, so the present author feels that he is indebted to specialists and scientific men, but in a very large way to the thouands and thousands of little beekeepers over all this land, who have not only shown him their methods and appliances, but have by letter and otherwise, helped to furnish the material that is given in these pages.

February 1, 1923. ERNEST R. ROOT.

Preface to the 1935 Edition

This edition more so than any of those that have preceded it, is almost a new book from cover to cover. All the titles have received some changes; many of them have been largely revised and others have been entirely rewritten. In addition, a large number of new titles have been added particularly under the head of honey. Much of the old matter has been taken out to make room for the new. The portions deleted were either somewhat obsolete or were too far removed from the general subject of bees. An example of this will be noted in the elimination of a large amount of matter covering the subject of pollination by insects other than bees. Much of the technical material on bee botany has been further cut out because the part removed will be found more fully covered in our other work, "Honey Plants of North America." Likewise all biographical and historical matter has been stricken out because the reader is interested not so much in what is past or who did it, as in a brief statement of the best practice today irrespective of its history or its source.

Why was it necessary to strike out so much of the old matter and add so much of new during the last six years?

In the first place, the food-chamber system of beekeeping referred to in the 1929 Preface, during the years since, has been so greatly extended that it has all but revolutionized modern methods of management of bees. It has so reduced the cost of honey

production that most of the old titles that have to do with methods of handling bees had to be slightly changed, revised or completely rewritten. Unless this had been done, the old articles would have been out of harmony. The food-chamber system has almost eliminated the old practice of feeding sugar syrup. It has modified fall and spring management. It has improved and simplified the methods of wintering. It has made it easier to winter outdoors. It has greatly simplified and reduced the labor of handling bees. In short, it has made many of the old methods obsolete and unnecessary. All this required not only the deletion of old articles but extensive revision or re-writing of other articles to bring them into harmony with the new system created by the food-chamber.

The present author believes he was the first to exploit breeding in two stories instead of one. See a series of articles he wrote in Gleanings in Bee Culture from 1894 to 1901. For a complete history of this early work see Gleanings in Bee Culture, pages 242-245 of 1923. In these articles he showed how it was possible to have powerful colonies that would have sufficient bees of the right age for the harvest. Mr. George S. Demuth, formerly in the government service, but later editor of Gleanings in Bee Culture, was the first to exploit the merits of the food-chamber instead of feeding. This, in connection with breeding in two stories, has revolutionized methods of management, by which it is possible to reduce labor and cost and at the same time produce a crop of honey, even in comparatively poor seasons. Demuth and Phillips worked out wintering so that it is not the unsolved problem it was for many years. Their joint work was one of the greatest contributions that bee culture has ever had. Phillips and White clarified the other vexing problem, bee diseases, so that the modern beekeeper no longer regards them as the serious handicap that they formerly were. During all these years, Phillips, Demuth, and Hambleton, in the Bureau of Entomology, have also worked out many of the minor problems of bee culture, so that the industry is now on a much more stable basis than it was formerly.

Second, our scientific knowledge of bees and their habits has been greatly increased. Some very fine work has been done in foreign countries. More than all else, our own Bee Culture Laboratory, of which Jas. I. Hambleton is the head, in the Bureau of Entomology and Plant Quarantine, Washington, D. C., as will be seen under the title, Government Aid to Beekeepers, has given us a vast amount of information. It has shown what foulbrood is and how to treat it, and has helped in the solution of many beekeeping problems. It has sent out hundreds of bulletins on all phases of beekeeping.

In a similar way research workers in our various schools of beekeeping at our state universities have not only confirmed the work done at the Bee Culture Laboratory, but have thrown new light on regional and climatic differences.

In addition to this, most of our states have either bee extension or bee inspection work or both. This work is taken directly to the beekeepers.

The bee journals, particularly the one of which the author is one of the editors, have kept the new practices and developments to the front. Much of the material for this edition was obtained from the back volumes as will be seen by the page references through the text of the work.

It is the scientific knowledge gained and disseminated in this way during the last few years that has made it necessary to bring all the articles in this work into line and the author believes he has accomplished this in the 1935 edition in a way that has never been done in any previous edition of this work. In short, he has tried to bring science and practice into a very close harmony in all the articles in the 1935 edition. This again has necessitated revising or re-writing many of the articles that have appeared in the previous editions but what at the time were thought to be up to date.

The author in re-writing the article on Foulbrood followed the lead of Mr. Hambleton of the Bee Culture Laboratory as set forth in his bulletin on the subject, No. 1713, United States Department of Agriculture. The methods of detecting these diseases, especially foulbrood, have been more fully explained than ever. The cure for American foulbrood has been radically changed from shaking to burning all infected material. The use of disinfecting solutions and the old plan of shaking the bees on to comb foundation, are not encouraged. When a conservative authority like Hambleton

of the Government, and when all the bee inspectors of the country, recommend burning as the only safe and sane treatment for American foulbrood, the author felt that he should fall in line. The reader will find in this edition a wholly new article.

In the same way other articles have been completely rewritten. In numerous cases new titles have been added.

Third. Honey, nature's only concentrated sweet, is the very foundation of a very wonderful and fascinating hobby, avocation or business—the keeping of bees. It is only the simple truth to say that honey has not hitherto had the recognition or attention in this or any other textbook on bees that it should properly receive. In late years honey is beginning to take a new place in the nation's dietary as a food and medicine. Beekeepers should not only know how to keep bees better but know better how to tell about the food values of honey, both for the sick and the well. The author and publishers of this work have felt that it is high time to gather and spread abroad the honest and true facts about honey as are set forth by competent authority both in this country and in Europe. The general subject of Honey and its various sub-titles in their alphabetical order will show what dietitians and medical men of repute both here and abroad say about honey. Probably no man in this country or possibly of all Europe can write more intelligently or authoritatively on the subject than Dr. E. F. Phillips, who is familiar with the literature on honey both in this country and in Europe. For many years he was head of bee culture research work in the Bureau of Entomology, Washington, D. C., and is at present professor of bee culture at Cornell University. He has written most of the special articles on Honey for this edition. Dr. C. A. Browne, formerly Chief of the Bureau of Chemistry and Soils, starts off the discussion on honey and Dr. Phillips follows him under various sub-titles given further on.

The reader will note that the edition of 1935 devotes twice as much space to honey as any former edition. The authorities whose opinions are given, have been selected with the greatest care. Most of the titles covering honey are new and will speak for themselves.

While the previous edition of this work emphasized the food chamber, the 1935 edition is built around honey as will be seen by the new titles. This is as it should be. The readers of a work of this sort should know about honey as well as the other subjects found in their alphabetical order.

Fourth. Beeswax, the other product of the hive, has taken a new old place in the art of candle making. (See Wax Candles.) The physical properties of beeswax have never been exploited before in any bee book. (See Wax Polluted by Resinous Gums.) Most of the matter on Wax, Wax Candles and Wax Pollution was written by H. H. Root, Associate Editor of Gleanings in Bee Culture.

When the author began to lay his plans for this edition, it was apparent that in order to cover all these four divisions adequately the time had come for the most radical and extensive revision that this work ever received. To that end he saw at once that he would have to call in some of the best men in the country, men who had made a special study both of the scientific as well as the practical phases of the four major subjects here outlined.

While the author has written most of the matter for this 1935 edition, he has not hesitated in some cases to incorporate into his writing the exact language of others who he felt knew much more than he did on some particular phase of a subject, especially the technical and scientific. To have paraphrased their work in his own language would have perhaps led to inaccuracies, confused the readers and broken the continuity of the statement. For the part purloined, acknowledgments have been made.

In addition to all this a very complete index has been prepared by the author with numerous cross references to each subject. The student who wishes to get all there is in a subject should consult the index and look up all the references that may perhaps be scattered from one end of the volume to the other. It is not possible to cover every phase of a subject under one heading.

The author, after going over the back volumes of the bee journals, page by page, for the last seven years, and after consulting the books and bulletins of the authorities mentioned, has written nearly 75 per cent of the matter in this edition. Where

no credit is given he assumes authorship. He deems it only fair, however, to give specific credit to those who have supplied the rest of the matter in complete articles not otherwise acknowledged. Foremost among those who have written whole articles is Dr. E. F. Phillips. Here is the list that should be credited to him:

Granulation of Honey, the Science of; Relation of Fermentation to Granulation; Honey, Some Physical Properties of; Honey Enzymes, Technical Statement of; Honey, Flavors of; Honey, Food Value of (first part of); Honey, Mineral Constituents of; Honey, Science of; Nectar; Parthenogenesis; Secretion of Nectar; Water; Yeasts in Honey.

He is likewise referred to in numerous places in the work.

The following articles were written by John H. Lovell, entomologist, botanist and beekeeper, Waldoboro, Maine.

All the botanical descriptions of honey plants; Bumble Bees; Clover; Alsike Clover; Honeydew, Pollen, except Pollen Substitutes

Dr. C. A. Browne, formerly chief of the Bureau of Chemistry and Soils, wrote the first part of Honey and the first part of:

Adulteration of Honey; also Glucose, Cane Sugar, Dextrose and Sugar.

W. J. Nolan of the Bee Culture Laboratory, Bureau of Entomology and Plant Quarantine, revised pages 15 and 16 of

Age of Bees; besides revising the earlier article by James I. Hambleton, on Fertilization of Queens by Artificial Means, he furnished some of material from foreign countries on Honey, Food and Medicinal Value of.

R. E. Lothrop of the Bureau of Chemistry and Soils, wrote the articles on

Colloidal Substances in Honey; Honey, Filtration of; Honey, Heat Effects on.

Mr. Lothrop also read proofs on the sub-titles on honey, making here and there suggestions and in some cases adding his own matter, which is incorporated.

Prof. H. F. Wilson, entomologist and head of the School of Bee Culture at the University of Wisconsin, has made honey a special study, especially the factors that have to do with its spoilage. See his article, Honey, Spoilage of.

Prof. P. H. Tracy, of the University of Illinois, furnished material on Honey Butter.

Mrs. Malitta F. Jensen, head of the American Honey Institute, furnished the matter on Honey, Cooking Value of, and the honey recipes. She also furnished matter for Honey Beverages and Honey Candies.

Dr. W. E. Dunham, entomologist and professor of bee culture at Ohio State University, wrote the articles on

Fire Blight and Tongue Measurements of Honeybees.

Fruit Blossoms was entirely re-written by the author with large additions by Prof. Ray Hutson and H. D. Hootman of Michigan State College.

Pollen has additional matter by Dr. Mykola H. Haydak of the University of Minnesota, St. Paul, Minn.

Propolis has likewise additional matter from Edwin C. Alphonsus of the University of Wisconsin.

Italians, the early history of, and introduction into the United States, is by Prof. F. B. Paddock of the University of Iowa.

Laws Pertaining to Bees up to Laws Relating to Foulbrood was written by Judge Leslie Burr, a man well versed in bees as well as law.

Geo. S. Demuth, for some years in the Bee Culture Laboratory, Washington, D. C., and thirteen years Editor Gleanings in Bee Culture, wrote:

Building Up Colonies; Comb Honey, to Produce; Swarming; Prevention of Swarming.

M. J. Deyell, in charge of The A. I. Root Company's bees, about 1000 colonies, and also one of the editors of Gleanings in Bee Culture, wrote part of

Beginning with Bees and Food Chamber. He also wrote Requeening, Requeening Without Dequeening, Supering, and Spring Management of Colonies.

Mr. Deyell's advice was sought in the 1935 edition.

W. K. Morrison, formerly of the West Indies, wrote:

Bees, Stingless, and Hives, Evolution of.

Dr. W. Ray Jones, of Seattle, wrote Honey, Sensitization of.

All the other articles or matter not otherwise credited were written by the author.

In a very special way the author feels indebted to Miss Mildred Hobart, for her painstaking care in reading these proof pages of this edition, every line of which

she has not read once but several times. It has been her special task to fit together the copy as it has come to her from the author while he was in Florida with the bee journals, bulletins and books around him.

Last but by no means least, grateful acknowledgments are here extended to Phillips and Hambleton for their courtesies and fine co-operation in the preparation of this revision. Since the untimely death of Geo. S. Demuth, a business and editorial associate of the author, it seemed fitting and altogether proper to call upon two of his (Demuth's) associates and admirers, Phillips and Hambleton. These men had worked together in the Government service for years in laying the very foundation of modern bee culture. It has been the task of the author to crystallize in a condensed form some of their work.

In this connection it is only fair to them to say that they have seen but a very limited portion of the copy after it had been prepared, for the reason that, with all their other work, it would have been a physical impossibility for them to have gone over nearly nine hundred pages of double column matter, some of it fine print. The reader is not to hold them responsible, or approving all that has been said in these pages. The author, after over fifty years of editorial and book work, has tried to give only those opinions and practices that are orthodox as of today. How far he may have succeeded the reader is to judge.

ERNEST R. ROOT.

April 1, 1935.

Introduction to the First Edition

BY A. I. ROOT.

About the year 1865, during the month of August, a swarm of bees passed overhead where we were at work, and my fellow-workman, in answer to some of my inquiries respecting their habits, asked what I would give for them. I, not dreaming he could by any means call them down, offered him a dollar, and he started after them. To my astonishment, he, in a short time, returned with them, hived in a rough box he had hastily picked up, and at that moment I commenced learning my A B C in bee culture. Before night I had questioned not only the bees but every one I knew who could tell me anything about these strange new acquaintances of mine. Our books and papers were overhauled that evening; but the little that I found only puzzled me the more, and kindled anew the desire to explore and follow out this new hobby of mine; for, dear reader, I have been all my life much given to hobbies and new projects.

Farmers who had kept bees assured me that they once paid, when the country was new, but of late years they were no profit, and everybody was abandoning the business. I had some headstrong views in the matter, and in a few days I visited Cleveland, ostensibly on other business, but I had really little interest in anything until I could visit the bookstores and look over the books on bees. I found but two, and I very quickly chose Langstroth. May God reward and forever bless Mr. Langstroth for the kind and pleasant way in which he unfolds to his readers the truths and wonders of creation to be found inside the beehive.

What a gold mine that book seemed to me as I looked it over on my journey home! Never was romance so enticing—no, not even Robinson Crusoe; and, best of all, right at my own home I could live out and verify all the wonderful things told therein. Late as it was, I yet made an observatory hive and raised queens from worker eggs before winter, and wound up by purchasing a queen of Mr. Langstroth for $20.00. I should, in fact, have wound up the whole business, queen and all, most effectually, had it not been for some timely advice toward Christmas, from a plain, practical farmer near by. With his assistance, and by the purchase of some more bees, I brought all safely through the winter. Through Mr. Langstroth I learned of Mr. Wagner, who shortly afterward was induced to recommence the publication of the American Bee Journal, and through this I gave accounts monthly of my blunders and occasional successes.

In 1867 news came across the ocean from Germany of the honey-extractor; and by the aid of a simple home-made machine I took 1000 pounds of honey from 20 stocks, and increased them to 35. This made quite a sensation, and numbers embarked in the new business; but when I lost all but 11 of the 35 the next winter, many said: "There! I told you how it would turn out."

I said nothing, but went to work quietly and increased the 11 to 48 during the one season, not using the extractor at all. The 48 were wintered entirely without loss, and I think it was mainly because I took care and pains with each individual colony. From the 48 I secured 6,162 pounds of extracted honey, and sold almost the entire crop for 25 cents per lb. This capped the climax, and inquiries in regard to the new industry began to come in from all sides. Beginners were eager to know what hives to adopt, and where to get honey-extractors. As the hives in use seemed very poorly adapted to the use of the extractor, and as the machines offered for sale were heavy and poorly adapted to the purpose, there really seemed to be no other way before me than to manufacture these implements. Unless I did this I should be compelled to undertake a correspondence that would occupy a great part of my time without affording any compensation of any account. The fullest directions I knew how to give for making plain simple hives, etc., were from time to time published in the

American Bee Journal; but the demand for further particulars was such that a circular was printed, and, shortly after, a second edition; then another, and another. These were intended to answer the greater part of the queries; and from the cheering words received in regard to them it seemed that the idea was a happy one.

Until 1873 all these circulars were sent out gratuitously; but at that time it was deemed best to issue a quarterly at 25 cents per year, for the purpose of answering these inquiries. The very first number was received with such favor that it was immediately changed to a monthly at 75 cents. The name of it was Gleanings in Bee Culture, and it was gradually enlarged until, in 1876, the price was changed to $1.00. During all this time it has served the purpose excellently of answering questions as they came up, both old and new; and even if some new subscriber should ask in regard to something that had been discussed at length but a short time before, it was an easy matter to refer him to it or send him the number containing the subject in question.

When Gleanings was about commencing its fifth year, inquirers began to dislike being referred to something that was published half a dozen years before. Besides, the decisions that were then arrived at perhaps needed to be considerably modified to meet present wants. Now you can see whence the necessity for this A B C book, its office, and the place we propose to have it fill.

December, 1878. A. I. ROOT.

Foreword

It is hardly necessary to remind the reader that this is an encyclopedia on bees. It should therefore not be read consecutively, but taken up subject by subject in the order indicated later. A preliminary statement should first be made in order that the beginner, at least, may be able to form at the very outset some idea of the scope and character of the industry which he is to study.

Bees have been kept from time almost immemorial. References to bees and "honey in the honeycomb" appear all through ancient history. Honey, aside from the sugar in fruit, was the only sweet then known, and hence was always highly prized. Bees were kept in caves, earthen jars, old logs, straw baskets, or skeps. After man contrived the art of making boards out of trees he constructed rude boxes which were called gums or hives. The skeps were made of braided straw, and these are still used to a considerable extent in Europe among the peasant classes who can not afford modern equipments, and who lack, even more, the mental capacity to put into effect modern methods. (See Skeps.)

The keeping of bees in the old days was but little more than an avocation or sideline in connection with some other business or profession. While the great majority of the beekeepers of today are probably amateur, or "back-lotters," those who keep a few bees for pleasure and profit, there are now thousands upon thousands who make beekeeping a vocation or business. Their colonies are numbered by the hundreds and even thousands, and their annual production of honey is measured by the ton and carload. While there were a few, both in Europe and America, who had as many as two or three hundred colonies, and produced honey by the ton, beekeeping as a specialty and as an exclusive business was scarcely known until after the advent of the movable-frame hive of Langstroth, the honey-extractor of Hruschka, and comb foundation of Mehring and Wagner. (See Hives, Extractors and Comb Foundation.) These inventions revolutionized the industry to such an extent that it is now possible for the beekeeper to produce tons where he could produce only pounds before.

In addition to the specialist class of beekeepers there are many hundreds of thousands who keep a few colonies in the back yard in cities and towns. There is also another large class, the farmer beekeepers, who keep a few colonies on the farm, not only for the purpose of pollinating their fruit trees, the clovers, and buckwheat, but to supply the family table with honey, the purest and best sweet in the world. (See Honey.)

The time was when Moses Quinby, in the 50's (and that was before the invention of the movable-frame hive by Langstroth in 1852), sent a canalboat-load of honey to the city of New York. This was more than the metropolis had ever seen before—so much honey, indeed, that it "broke down the market," and the honey went begging for a customer. In these latter days that same market is able to dispose of hundreds and hundreds of carloads of honey that have been shipped in from all over the United States, but mainly from the irrigated regions of the West.

A conservative estimate of the total number of persons who keep bees, either as a vocation or as an avocation, is 500,000 beekeepers in the United States alone.

According to estimates submitted by the Bureau of Agricultural Economics of the United States Department of Agriculture, a five-year average production of honey in the United States, from 1929 to 1933, was 172,226,870 pounds. It may be difficult for most of us to get a mental picture, or even a meager conception of this amount of honey. On the basis of 36,000 pounds to a minimum carload of honey, this nine-digit number of pounds would make 4784 carloads, or a single trainload of honey approximately 36 miles long. If this amount of honey were put into one-pound jars and stood, side by side, close together in a row, this row of jars would extend over 8157 miles, or about one-third of the distance around the earth.

Even this seemingly enormous amount of honey, 172,226,870 pounds, would supply only a little over a pound for each of the (approximately) 125,000,000 people in the United States. If all the people in the country could be induced to eat honey, nature's oldest and safest sweet, regularly, instead of some of the sugar that is now consumed

(over 100 pounds per capita)), this seemingly big pile of honey would disappear in a week or ten days. It requires no wide stretch of the imagination to foresee what will happen to the beekeeping industry when the public actually begins to consume honey.

Honey is being used as a food as it never was before. (See Honey, Honey as a Food, Extracted Honey, and Comb Honey.) Honey is now found in the best hotels and restaurants, on dining-cars of the great trunk line railroads, and in all leading groceries. It is now being put up attractively in comb and liquid form. (See Bottling Honey.)

As a food, honey merits a rather unique position. In the first place, it is the only concentrated sweet found as such in Nature. Perhaps this very fact would lead one to expect that which dietitians and many physicians tell us is true: that honey does not burden the digestion like ordinary sugar. Although honey is chiefly invert sugar, it differs from the commercial product in several important respects. Among these might be mentioned the occurrence in honey of a variety of mineral elements, all of which are essential in proper nutrition. The amounts in which these elements are present are not negligible, as some have assumed. On the contrary, they are of considerable importance, especially when it is considered that no other commercial invert sugar contains any available minerals worth mentioning. (See Honey, Medicinal Value of, Honey, Mineral Content of, and Honey, Science of.)

The farmers of this country now know the value of sweet clover as a forage plant for cattle and hogs (see Sweet Clover). In many localities it is nearly if not quite the equal of alfalfa. This clover will grow on poor land, and restore poor soil as almost nothing else will do. The farm papers all over the country are already pro claiming the virtues of sweet clover. The experiment stations extol it everywhere. So far from being a "noxious weed," it is one of the most valuable legumes ever known. Important to beekeepers, sweet clover is a honey plant—one of the best in this country.

Alfalfa is now being grown in the East and from it comes alfalfa honey.

Owing to the fact that many of the former clover soils are not growing clover as they formerly did, the experiment stations of the country, as well as the general agricultural press, are advocating the use of lime in one and two ton lots to the acre. Where this has been applied there has been an enormous increase in the production of all the clovers. Alsike clover, on account of the practice of liming the soil, is being introduced into localities where it has never been known before. So thoroughly is the gospel of lime being disseminated over the country that the business of honey production, which had been largely dependent on the clovers is being enormously stimulated. (See Clover.)

The work being done by the Bureau of Entomology, Washington, D. C., to stimulate apiculture in the United States, is beginning to have its effect. This, coupled with the work done by the various state experiment stations and the extension men of the farm bureaus, is spreading not only the gospel of lime, but also the gospel of honey production and the pollination of certain legumes and fruits.

We made the statement that something over 172,000,000 pounds of honey is produced annually in the United States alone. If that were all the bees did in this country it would be a fine record. From an economic standpoint they do far more than this. There is no other agency in the world that does such perfect work in pollination—that is, bringing the pollen of one blossom to that of another—as the honeybees. There are countless thousands of them at a time of the year when comparatively few other insects are present. They therefore make it possible to produce more and better fruit. (See Fruit Blossoms, also Pollination.)

The ratio of fruits aided by bees through pollination to the total production of honey and beeswax is about twenty to one in most states. This means that from the standpoint of horticulture, bees are twenty times as necessary or important than they are in the production of honey and beeswax. When, therefore, the solons, or lawmakers of Washington, D. C., or of the various state capitals claim that the production of honey is not worth the appropriations asked for, they should be told that the bee industry should not be evaluated by the amount of honey and beeswax produced, but by the amount of fruits which the bees make possible in state and nation. This fact is often lost sight of by those who make up the appropriations for the

various industries. (See Statistics Concerning the Bee and Honey Business, in the body of the work.)

This in brief is a general survey of the industry. It will now be proper to refer the reader to the series of subjects which he should take up. Each will be found in its regular alphabetical order; and when these have been read, the reader can then take up the other subjects as he chooses. But it is suggested that, if he can possibly secure a colony of bees, he should do so in order that he may study them intelligently and apply the teachings of this book as he goes along. The following course of reading is recommended:

A B C of Beekeeping; Beginning with Bees; Package Bees; Anger of Bees; Manipulation of Colonies; Apiary; Bee Behavior; Smoke and Smokers; Stings; Hives; Transferring; Robbing; Back-lot Beekeeping; Brood and Brood-Rearing; Building Up Colonies; Food Chamber; Feeding; Swarming; Extracting; Comb Honey; Spring Management; Uniting; Wintering. The other subjects may be taken up in any order that may seem best.

ERNEST R. ROOT.

A. I. ROOT

A

A B C OF BEEKEEPING—The reader will better understand the general articles in this work if he will follow the course of reading suggested in the last paragraph of the Foreword on the opposite page.

At the very outset it is important that a bird's-eye view be taken of the whole industry; and to do this it will be necessary to make a brief summary of the contents of this work. The reader, having a comprehensive view of the business, the ways and means and whys, will then be able to take up specifically a course of reading as suggested at the close of the Foreword.

The Inmates of the Hive

There are two different kinds of bees —solitary bees and social bees, those that live in colonies or communities. There are many species of both kinds; but for the purpose of this work only social bees, and mainly the species known as *Apis mellifica*, or "honey-makers," will be considered.

There are three classes of individuals in each colony — namely, the queen bee, or true female, the drones, and the workers, or neuter bees as some call them, but, more correctly, undeveloped females. Each worker bee is functionally much the same as the queen bee except that her tongue, mouth parts, pollen-gathering bristles on the legs, and the sting are more fully developed than the same organs in the only true female, known as the "queen." (See Queens.)

A colony of bees may contain from 25,000 to 75,000 individuals, and in rare cases as high as 100,000, all the daughters of one queen bee. As the bees die off constantly she may, during the whole season, become the mother of a quarter of a million of bees. But the average good colony for producing honey will run from 50,000 to 75,000 workers. During the winter this number will be reduced to considerably less than half, for Nature apparently goes on the assumption that it is wise not to produce a lot of unnecessary consumers for winter.

The duties of the worker bees are quite varied. Primarily their business is to gather nectar or sucrose, and, by some chemical process which is not fully understood, change it into invert sugar or honey. Since they gather nectar and make it over into honey, it is scientifically accurate to say that bees "make honey." (See Honey.)

Bees also gather pollen from the flowers, and store it in combs the same as they store honey. (See Pollen.) The pollen and honey are used for making a milky-white nitrogenous food to feed the larvae or baby bees. This food is very much like thin condensed milk. As the larvae develop, this same food, or "pap," becomes more abundant. (See Brood and Brood-rearing.)

Bees also gather a kind of glue for making what is called bee glue, or propolis. This is used to seal up all cracks that might let cold air into the hive. The word "propolis" is derived from two Greek words, *pro*, meaning in front, and *polis*, a city. In ancient times, and with some strains of *Apis mellifica* today, the bees used this substance in front of the hive to contract the entrance in order to keep out other insects and rodents, hence the name, *in front of the city*, or propolis.

It is also the duty of the workers to

Queen. Drone. Worker.

guard the entrance against robber bees from other hives, and other insects that sometimes will attempt to invade the hive to steal the honey, to build comb, and to feed the young larvae or grubs. At this point it should be noted that there is a beautiful division of labor by which the older or mature bees go to the fields in quest of pollen or nectar, while the younger bees do the inside or housework, as already stated.

The Queen

Contrary to the general belief, the queen is not the ruler or "boss" of the colony. She is, in fact, little more than an egg-laying machine subject to the caprices of her daughters. She is, however, treated with great respect and attention. Her bees will circle around, feed her, comb her hair, and give her a bath, as long as she can and will lay her full quota of eggs for the season; but when she begins to fail her daughters will take one or more of her eggs and proceed to raise another queen. These eggs, if put into worker cells and the larvae fed regulation food, would produce only more worker bees, or undeveloped females. (See Brood and Brood-rearing.)

The worker larva, if given a special cell and special food, develops sexually so that she becomes a perfect, or true, female, or what is called a "queen." As already stated, she is structurally much the same as the workers with this difference: Her mouth parts, pollen-gathering apparatus, as well as her sting, are aborted, while her spermatheca and ovaries are highly developed. She is capable of laying as many as 2,000 eggs in a day, but her average during the breeding season is less than half that. During the height of the season she will not average, probably, over 1,500 eggs a day. At the close of the active season her egg-laying diminishes greatly, sometimes stopping altogether. This seems to be a wise provision in nature to prevent the rearing of a lot of useless consumers that would simply use up all the stores before winter comes on. In the matter of birth control they excell all animated creation.

Along in the fall, if there should be a fall flow, egg-laying may start again, and a lot of young bees may be reared to make up a colony that will go into winter quarters. The bees that gather the crop during an active honey season very seldom if ever live to go into winter quarters. The fruit of their toil goes to their successors.

Only one queen bee, under normal conditions, is allowed in the hive at a time. The worker bees, apparently, are willing to tolerate one or more queens; but evidently the queens themselves are jealous of each other, and, when they meet, a mortal combat follows, during which one of them receives a fatal sting. The reigning queen bee, then, is often the survival of the fittest. Sometimes mother and daughter will get along very nicely together and perhaps even winter together, but usually along toward fall the mother disappears. Whether the daughter helps to make away with her, whether she dies of old age, or whether the bees take a hand in the matter, is not known.

The average queen bee will remain the mother of a colony for from two to three years. She may live to be as old as five or six years, but these cases are very rare. Usually a queen over two years old is not worth much, and most of our best beekeepers believe that a queen over a year old should be replaced by a younger one. (See Age of Bees.)

The Drone

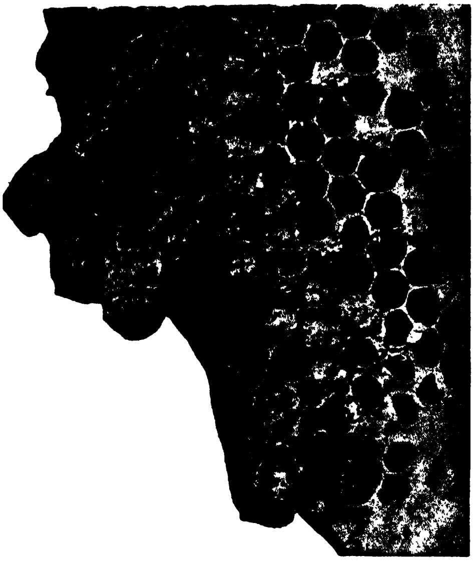
There is another individual known as the drone. His mouth parts and pollen-gathering apparatus are all very much aborted, and he has no sting. Drones are competely at the mercy of their sisters, and their only purpose is to mate the queen bee. This act takes place in the air, for apparently Nature has designed to prevent in-breeding. After the main honey flow is over, the drones are rudely pushed out at the entrance by their sisters, where they soon starve to death. (See Drones.)

The average young queen, when she sallies forth in the air on her wedding trip, may or may not find her consort from the same hive, but the probabilities are she will find one from some other hive. As soon as the act of copulation has taken place the two whirl around in the air until they drop, when the queen tears herself loose, carrying with her the drone organs, after which the drone dies.

Strange as it may seem, but it is nevertheless a cruel fact, the drone when he attends his wedding also attends his funeral. That is another way of saying that his wedding march (flight) is followed immediately by his funeral dirge, with no one to mourn his death. His queen doesn't

need him further and she thereafter becomes a widow for the rest of her life, but a widow that does not mourn. (See Drones.)

Soon after she enters her hive the drone organs are removed by the worker bees, but the spermatic fluid is retained in the spermatheca, where a supply sufficient to last the rest of her life is held. The queen is from that time on able to lay fertilized eggs that will produce worker bees, and infertile eggs that produce *only drones*. (See Drones and Dzierzon Theory.)

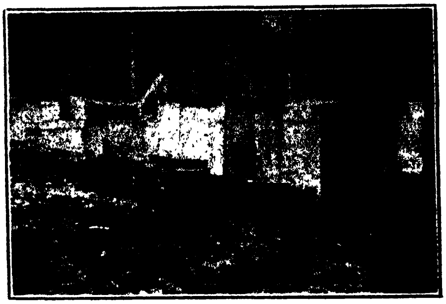


Natural built queen-cells, life size.—Photographed by W. Z. Hutchinson.

The same egg that produces a worker bee, strangely enough, will also produce a queen bee. The question of whether an egg shall be developed into a queen or an ordinary worker depends entirely on conditions. If the bees desire to raise a queen, or several of them, they will build one or more queen-cells, and feed the baby grubs a special food. (See Queens and Queen-Rearing.) In 16 days a perfect queen will emerge; while in the case of a worker, fed on a coarse food in small cells, 21 days elapse. Such, in brief, is a statement concerning the inmates of the hive and their duties.

The House They Live In

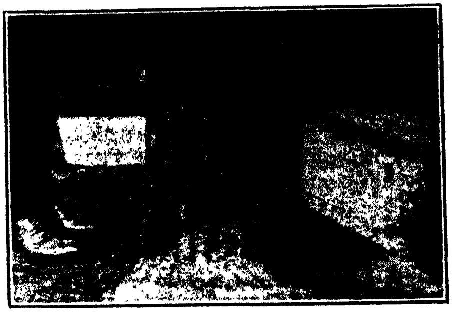
Before proceeding any further it will be proper to say something about the house or hive. In doing this the old box hive of our forefathers will be shown first, then the modern hive which has made it possible to handle bees with such infinite pleasure and profit.



A typical box-hive apiary such as is to be seen all over the Southland.

The Old Way of Keeping Bees

The primitive box hive of our grandfathers, consisting of a rude box (hence



The inside of a box hive after the bees have been drummed out. Notice how immovable the combs are.

the name), was 12 or 15 inches square, and from two to three feet deep. Through the center were secured two cross-cleats

Tipping up the hives in a box-hive apiary, one after another, and looking "up under" to learn their condition. This is all the "inspection" box-hive colonies receive.

at right angles to each other, to help support the combs. (See Box Hives.) This box hive, standing on a board or slab, usually had a notch at the bottom in front, to provide an entrance. The bees, when building their combs in such a hive, fastened them to the sides and ends over and around the cross-cleats. The combs, when so built, would, of course, permit of no examination or handling, as do the modern hives, except by tipping up the hive as shown in the cut on previous page; and when it was desired to take the honey, the bees of the heaviest hives in the fall were brimstoned, while those of the lightest were allowed to live over until the next season, to provide for swarms to replace those destroyed. The honey taken from box hives was mixed with beebread and brood, and was of inferior quality. The combs were cut out of the hive and dumped into buckets to be used as wanted for the table.

The modern hive has long since eliminated these crude and cruel methods, and in their stead has substituted humane, sane and safe methods of taking the honey. There is accessibility to every part; and, so far from destroying the little servants, one can take their honey without a sting if directions are followed. Every comb is now built in movable frames that permit of easy examination. (See Frames.) One can open the hive and remove the frames, playing with the bees by the hour if he knows how. There is no more alluring pastime for the business or professional man or the housewife than the keeping of bees. They all say it's just fun, and it's "fun" that makes money. (See Backlot Beekeeping.)

The Modern Hive for the Production of Comb and Extracted Honey

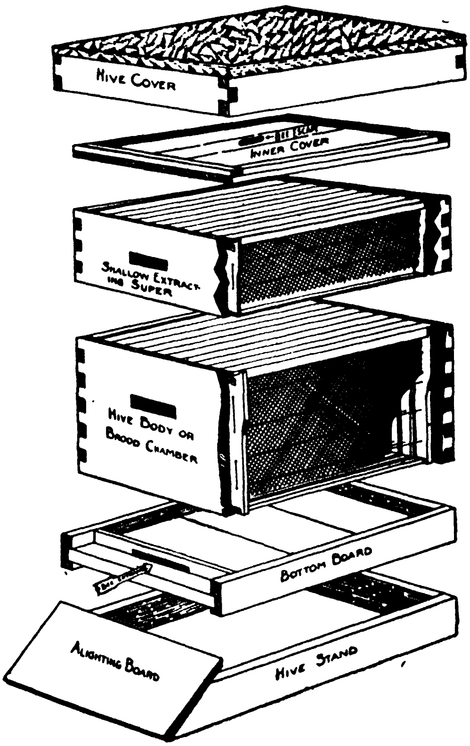
The modern hive or exterior housing, in its simplest form consists of a floor or bottom-board; a hive-body (box without cover or bottom) to hold the frames or racks to contain the combs; supers (shallow box rims) to hold section-holders for the sections for comb honey, or extracting-frames for extracted honey; an inner lid, or "super cover," and over the whole an outer or weather cover as shown. In addition there is an entrance-contracting cleat that can be removed so that a wide or narrow opening may be used, depending on the season and the strength of the colony.

In the best-regulated apiaries, hive-stands are used for holding the hives. These protect the bottom and hive proper from unnecessary exposure to the ground and rot, and at the same time provide an easy grade or alighting-board for the convenience of heavily laden bees as they come in from the field.

Each of the hive parts here enumerated is separable, interchangeable, and fits the other parts. One part can be piled on top of another in such a way as to accommodate the largest colonies and the largest yields of honey that may be secured.

Brood Frames

The inside of a modern hive is made up of movable combs held in wooden



Modern hive with Hoffman frames for production of extracted honey. Between super and hive-body should be a queen-excluder. (Deep extracting-super identical with hive-body may be substituted for shallow extracting-super.)

frames that can be taken out or put back. The problem of making a comb or frame movable was not an easy one, because bees use large quantities of bee glue, a sticky substance that they use in closing up all cracks and crevices to shut out the cold and to strengthen the combs near the point of attachment. This same glue

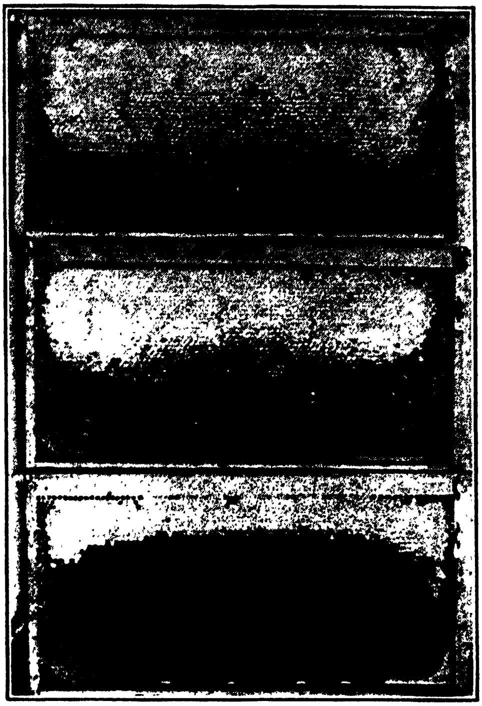
they use in fastening parts of hives together. A number of inventors devised movable combs, so-called, but on account of the bee glue, and on account of mashing and irritating bees in removing the combs, the old box hive continued to be used. It remained for L. L. Langstroth, in 1852, to devise a frame that avoided both of these difficulties, and yet made it possible to examine every comb with perfect ease and freedom from stings, and without mashing a single bee.

Langstroth was the first to discover the principle of a bee-space—a space that the bees never fill with bee glue or comb—approximately $\frac{5}{16}$ of an inch wide or deep. In nature bees leave these bee-spaces for passageways between their combs and the hive so that they can go around and between the combs. The bee-spaces are in reality streets and alleys in their little city.

When Langstroth developed his movable frame he made the dimensions so that there would be a bee-space or a bee-alley between the frames and the hive and between the frames themselves. In order that this space might be preserved all around his movable frame and still not be stuck fast by bee glue, he suspended it so that it hung from projections from each of the two top corners. These projections were formed by lengthening the top-bar of the frame so that the extreme ends would rest in what is known as a ledge or rabbeted space. In this way the frame has the smallest point of contact with the hive, and at the same time a bee-space of $\frac{5}{16}$ of an inch is allowed between the frames. (See Bee-Space.)

While this might seem like a very simple plan of providing for the bee-spaces and preventing the mashing of bees, it really required a stroke of genius to bring about the combination. All other so-called movable frames were almost *immovable* and awful bee-mashers. The bees would glue them fast to each other and to the hive because there were no bee-spaces. Then when the frames were pried loose they would come out with a bang, jarring the hive and irritating the bees. So important was Langstroth's invention that it readily revolutionized the keeping of bees throughout the world.

The only improvement which has been made in the Langstroth frame was in widening the end-bars so that the frames would be spaced a bee-space apart automatically. While an expert beekeeper could space the frames one by one $\frac{5}{16}$ of an inch apart, or $1\frac{3}{8}$ inches from center to center, it has been found that careless beekeepers, having no eye for distances, and beginners, not recognizing the importance of exact bee-spaces, would place the frames too close together or too



Combs three-fourths, one-half, and one-fourth capped. The uppermost is fit for extracting after shaving off the cappings as shown by the part in white.

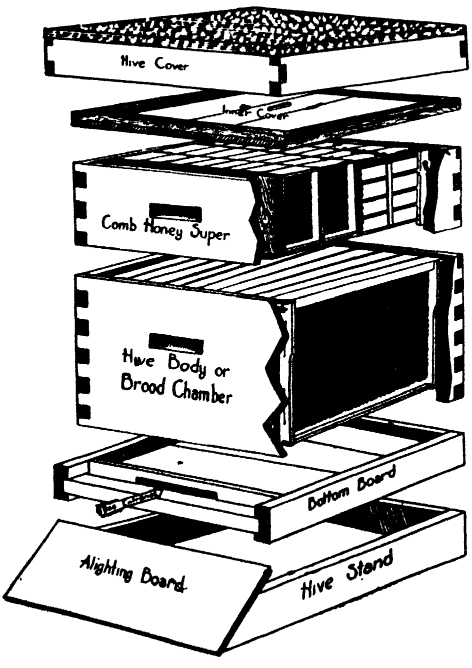
The honey is thrown out of the comb by centrifugal force.

far apart. For this reason came the improved Langstroth or Hoffman frame. (Under Frames, Frames Self-Spacing, and Bee-Space this subject is discussed at greater length.)

The part of a hive containing a set of frames for storing surplus honey is called a "super." Brood-chambers are generally deep, but the supers may be either deep or shallow. The honey may be removed by cutting the combs from the frames in the supers and storing them in tin cans, or it may be "extracted" from the frames of combs by means of a honey extractor. The honey so taken is called extracted honey. (See Extracting.)

Every comb has a series of honey-cells on each side, which, when filled with honey, are capped over with a thin film of wax. This capping is sliced off with a sharp-bladed knife made for the purpose, called an "uncapping-knife." The combs, with the cappings removed, are then placed in the baskets, or wire pockets, of a centrifugal honey-extractor. These baskets, fastened in multiples of two or more in a reel, are geared to run at a relatively high rate of speed inside of a metal can. The honey is thrown out by centrifugal force from the side of the comb next to the can. The machine is stopped; the combs are reversed, then the reel is started revolving, throwing the honey out from the other side also. In the very large machines, as shown in the "Simplicity" (under Extractors), the combs are set like the spokes of a wheel and are not reversed. When emptied the combs are put back into the hive and refilled with honey, after which they are again extracted as before. This process may be repeated one or more times during the season, or as long as the honey flow lasts.

The empty comb after extracting may be put back and refilled by the bees.



Modern hive with Hoffman frames for the production of comb honey. (Any style of comb-honey super may be used.)

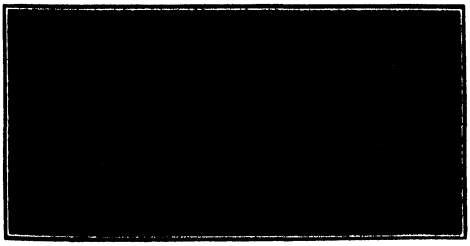
Extracted or liquid honey can be produced for less money than that in the comb, because the empty combs can be used over and over, year after year. As the bees consume from 5 to 10 pounds of honey to make a pound of wax, producing extracted honey saves making comb each time, and, of course, saves the honey required to produce the wax for the comb.

Sections and Separators as Used in Comb-Honey Production

The production of honey in the comb requires a different set of fixtures. Comb honey is produced in little square boxes technically called "sections." These are usually either 4 x 5 x 1⅜ inches wide, or 4¼ square by 1⅞ wide. These sections, four in number are placed in a sort of frame called a "section-holder." Between each two rows of sections, when placed on the hive, is a wooden separator consisting of a thin piece of veneer wood a little narrower than the section is deep. Sometimes a series of thin slats, fastened together by cross-cleats, are used in place of separators. Technically these are called fences. The purpose of the separator or fence is to separate the rows of sections from each other. Without them the bees would build the comb in these sections too fat or too lean. So far as possible it is highly important, from the

The uncapped combs being lowered into a honey-extractor.

marketing point of view, to have the combs in all sections of approximately the same weight—between 12 and 14 ounces. While the sections, including the wood, will hold an even pound when filled entirely full, it is very seldom that the producer of comb honey can get his bees to make his sections run uniformly one pound in weight. The average market permits and expects that comb-honey sections will run slightly less than one pound. (See Comb Honey.)



Comb foundation, which the bees have started to draw out in the center.

Comb Foundation

In order to start the bees building their combs centrally in the section or brood-frames, a product known as "comb foundation" (quite generally abbreviated "fdn.") is used. This consists of a thin sheet or sheets of pure beeswax embossed or indented, with a surface that is an exact duplicate of the midrib or center of the honeycomb with the cells sliced off. In other words, comb foundation is a duplicate of the foundation of the natural comb, and hence the name. The artificial product has more wax in the initial cells than the natural product. This surplus is used by the bees in building out their comb.

In modern apiculture foundation is almost an indispensable article. It is used either in narrow strips called "foundation starters," or in full sheets. The latter are preferable, because the bees will build more nearly perfect combs—combs that are flat as a board and a duplicate of the article built wholly by the bees. Without comb foundation the bees will

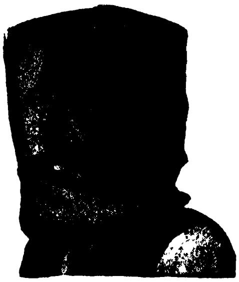
show a tendency to build their own product in all kinds of fantastic shapes, cross-

Bee-smoker.

wise of the section honey-boxes or the brood-frames. Practically all the combs in modern apiculture today are built on comb foundation. This is filled with honey by the bees, and capped over, and in all respects is equal or even superior to that made by the bees without the use of starters. (See Comb Foundation.)

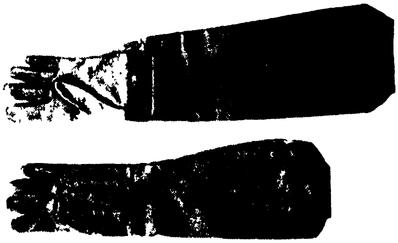
Tools for Handling Bees

The tools required by a beekeeper for opening his hives and doing other neces-



sary work in the production of honey are not elaborate. First and foremost, there must be a bee-smoker—an implement consisting of a tin stove mounted on a bellows. A pressure on the bellows blows a blast of air through a slow-burning fuel in the tin stove; and this air, charged with smoke, is forced onto the bees. The effect of the smoke is to quiet them and drive them. When rightly applied, and at the right time, smoke frightens or demoralizes them and at the same time takes away all desire to sting. Without smoke,

Bee-veil.



Bee-gloves with fingers.

many manipulations would be very difficult; and the novice, at least, would be inclined to give up the business after his first experience in trying to handle a colony of bees, especially if weather conditions were unfavorable. But with smoke and an instrument for applying it, one can, if he knows how, perform all possible manipulations with bees when weather conditions are right.

Bee Veils

The other tool, if it may be so regarded, is designed for face protection. This may be in the form of a wire-cloth cylinder with suitable cape to protect the neck and shoulders, or it may be made of some sort of netting, preferably black, so as to

Hive-tool.

obscure the vision as little as possible. The higher-priced veils of silk Brussels netting offer practically no obtruction to the eyes, and at the same time give the wearer a sense of security that he can not otherwise have.

Some beekeepers wishing to get through with as large an amount of work as possible, and knowing that rapid manipulation has a tendency, in spite of smoke, to make bees sting, wear both bee-veil and gloves; and a few of the careless bunglers go so far as to wear cowhide boots in addition, tucking the trousers into the boots. Good beekeepers do not approve

of such bungling, slam-bang methods, that only irritate the bees. One will accomplish as much or more in a day, provided he works cautiously and deliberately, using headwork to save making a multiplicity of quick moves. A few slow movements carefully planned will accomplish much with bees.

Almost the only other tool required is a strong screwdriver, a knife with a good stiff blade, or, better still, a specially constructed hive-tool made of spring steel with a broad blade for the purpose of a pry or scraper. A tool of some sort is indispensable for separating the frames and the parts of a hive, because the bees make use of what is known as bee glue, cementing the frames together. In warm or hot weather this bee glue does not cause as much trouble as during cold weather, when it is stiff and hard. Ordinarily bees should not be handled at such times.

A part of the pleasure derived from beekeeping comes from a thorough understanding what is going on within the hive.

Manipulating a Colony of Bees

Having considered the inmates of a hive, the hive itself, and its several parts and the tools, it is now in order to take up the manipulation of the hive, or the handling of a colony of bees.

The average beginner at this point may dread the job. He may get stung, when his face will be disfigured so that he will not be presentable in company. While it is not denied that he *may* get stung, the one who tries for the first time to handle bees should protect his hands with gloves and his face with a veil, because they will take away that feeling of fear that might cause him to make a false move and thus incite the bees to sting.

If he will follow the directions that are now given, he should not receive a single sting even in his clothing. First of all, it is important that the beginner select a warm day, between ten and three o'clock. After having lighted his smoker (see Smokers), he should put on his veil and gloves and approach his hive. He should be sure that the smoker delivers a good smoke. The best fuel is old rags or greasy waste, which can be had for the asking at almost any machine shop. This can be easily ignited with a match. The smoke of this it not pungent, but is a bluish white and quite opaque. Work the bellows until a good volume of smoke is secured. Care should be taken not to work the smoker bellows too hard, as otherwise the fuel

will burst into flame. With the smoker just right, blow a light puff of smoke into the entrance. Too much smoke will start the bees on a stampede, especially if they are blacks or hybrids. While bees will not sting in this condition, it renders subsequent manipulation exceedingly difficult.

The next movement is to take the screwdriver or hive-tool and after lifting off the outer cover pry the inner cover up about a sixteenth of an inch—not wider, because the bees would escape. Through the gap so made between the cover and the hive itself two puffs of smoke should be blown. Next, the cover should be gently lifted, the movement being followed with perhaps two or three light puffs of smoke. It is just as important not to use too much smoke as not enough.

One may now proceed to lift out individual frames. If they are stuck together on account of the bee glue, a little smoke may be required to follow each operation in separating the frames; but usually the smoker can be set down alongside the hive, and frame after frame be lifted out without receiving a single sting.

Care should be taken not to pinch any bees. The fingers should always be placed at some point where there are no bees. If they are very numerous, they should be gently brushed over to one side by pushing the fingers down between them, being careful not to pinch them in doing it.

After one has opened a hive a few times he will be able to discard the gloves, and later he can dispense with the veil at times, because he will find that an intelligent use of the smoker will do more to eliminate stings than any other one thing. After one has acquired a sense of freedom and knows the bees will not sting, he can work over them for hours at a time, getting more real joy out of his pets than from anything else on the place. (See Manipulation of Colonies.)

Before the reader proceeds further he should read very carefully the following subjects, found in their alphabetical order, viz., Beginning with Bees, Manipulation of Colonies, Brood and Brood-rearing, Anger of Bees, Stings, Smoke and Smokers, Apiary, Back-lot Beekeeping, Farmer Beekeepers, Hives, Transferring, Robbing, Uniting, and Wintering. This order is suggested because the arrangement is progressive and enables the beginner to proceed from one subject to another. After he has read these subjects he may take up Queen-rearing, Comb and Extracted Honey, or any other subject in which he may be interested.

ABNORMALITIES OF BEES. — See Hermaphrodite Bees; also Drones with Heads of Different Colors, under Drones.

ABSCONDING SWARMS.—An absconding swarm may be briefly defined as a run-away swarm that belongs to no one. Sometimes it may be seen flying across country. (See A. I. Root's introduction to the First Edition of this work.) At other times, it may be in the form of a cluster on a bush or tree. In either case, if it has not been pursued by its former owner it may become his property who follows or finally captures it. Up until the time it is hived it is defined in law as *ferae natural,* wild by nature, belonging to no one—not even to the original owner, unless he can prove that he followed the bees in flight, and kept them constantly in sight until they clustered. (See Laws Relating to Bees.) Usually when a swarm comes out, it makes such a demonstration in the air that some member of the family of the owner hears the roar. As soon as the bees cluster they are hived, as described under the general head of Swarming.

The Remedy for Absconding

The modern beekeeper can prevent such absconding or lost swarms by clipping the wings of all his queens so they can not fly. When a swarm issues even though all the members of the family are absent, the swarm will automatically return to the hive from which it came and the queen unable to fly and crawling on the ground will return with the bees; but if some one is at home he should cage the queen while the swarm is in the air, remove the old hive, put another with empty combs in its place, and place the caged queen in front of the new hive. The swarm will return to the queen.

In this way clipping as explained under Queens will prevent all absconding and the necessity of climbing tall trees to get the swarms.

It should be explained to the beginner that a swarm will not leave without a queen and if she can not fly, the bees will soon return to see what is the matter. Even when the wings of the queen of the

As a rule, a swarm will cluster on a limb of a tree or a bush. In a few cases they will cluster on the ground and in the grass. In rare cases they will alight on a fence, as here shown.

issuing swarm are not clipped, flying bees will almost invariably form a cluster on some limb or bush. The bees and the queen may remain in cluster form for a couple of hours and then light out for parts unknown.

It is generally believed that such clustering is for the purpose of awaiting the return of the bee scouts that have already picked out a hollow tree. As explained under Swarming, the scouts will on returning lead the swarm in a bee line for the new abode some miles distant. (See what Latham has to say on scout bees under head of Swarming.)

If no one hives this cluster before it starts, it will soon break cluster, form a big absconding swarm and hike for the woods.

Absconding After-Swarms

After the first or prime swarm from the old or parent colony, there may come forth a second or third swarm, generally called **after-swarms**, each headed by one or more virgin queens. When these queens go out to meet the drone, they will often lead out a little swarm. (See Drones, also Queens.) This may be followed by a third swarm still smaller, with one or more virgins. These little swarms will leave with a virgin as quickly as they will with a mature laying queen.

The intelligent beekeeper can and should provide against all after-swarming, and this can be accomplished in the manner explained under the heading After-Swarming.

Absconding Because of Abnormal Conditions

Sometimes conditions in the hive are so unbearable that the colony will suddenly and without warning swarm out, taking every bee. Ants in the South, or dragon flies in Florida, will so pester a colony that all of a sudden every bee in the hive will rush out as an absconding swarm without even clustering. Apparently they get in a panic, rush out and are gone, leaving not a single bee to take care of the brood. It has been reported that snakes or mice may cause such a panic. Sometimes the dragon flies are so numerous that there are great swarms of them in the air and the poor bees will not dare to go out, but when they do they abscond in a body.

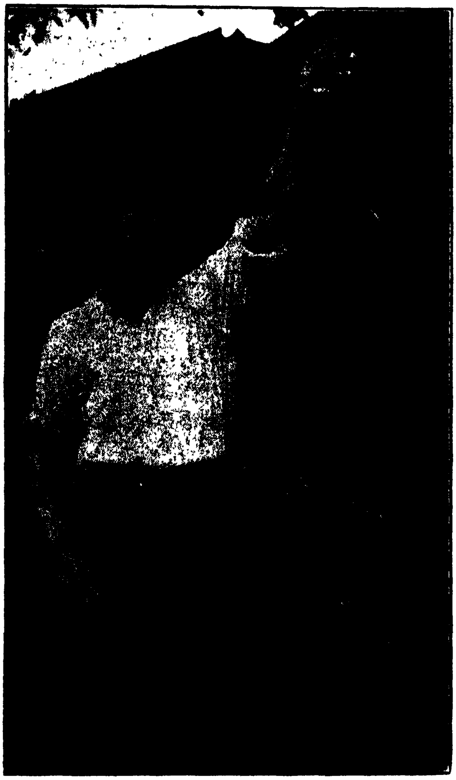
A swarm that came back because the queen was held in an Alley trap.

At other times, the entrance of the hive is so restricted and the sun and general weather conditions so unbearable that the poor bees are forced out of the hive. Again, foulbrood will make such a rotten stench that the bees take "French leave" and without warning to the apiarist.

Again, when the stores in a hive are completely exhausted, the inmates will swarm out. Absconding from starvation is not uncommon, especially in early spring. The remedy is obvious. (See Feeding.)

Absconding from Baby Nuclei

It is not an easy matter to hive a handful of bees in a little box with a virgin



A swarm that clusters on a small limb can be easily captured by cutting the limb just above the bees with a sharp pocketknife. Care should be taken not to jar the cluster in cutting. A sharp knife is much better than a saw for this purpose.

queen. When she goes out to mate all the bees may go out with her, never to return. (See Queen Rearing.)

ABSORBENTS.—See Wintering Outdoors, subhead Non-porous or Absorbing Cushions.

ACTIVITIES OF BEES.—See Bee Behavior.

ADULTERATION OF HONEY.—The adulteration of this product dates back many years, but the methods of detecting it are of comparatively recent date. Accum, in his "Treatise on Adulterations of Food and Culinary Provisions" (one of the earliest works devoted to food adulteration), published in London in 1820, does not cover the subject of honey. Hassall in his "Adulteration Detected," published about 1855, mentions honey. His examinations were made with the microscope, and he was able from the pollen to tell the kinds of flowers visited by the bees. He also noted crystals of sucrose intermingled with those of dextrose when a honey was evaporated to the crystallization point. In his later editions he gives methods for detecting sucrose and also commercial glucose. The two works cited above were written in England. Hoskins in his book, "What to Eat," possibly the first book on food adulteration written by an American, and published in Boston about 1861, states that "Factitious and adulterated honey is very common in our markets. The substances used are generally ordinary sugar, made into a syrup with water, and flavored with different articles. This preparation is usually mixed with genuine honey, and so extensive is this practice that very little 'Strained Honey' can be found which is pure. The only really injurious adulteration as regards health which I have found in such honey is alum." He noted "glucose and starch sugar among the adulterants of honey," but never verified their presence. Later work seemed to show that if one wanted pure honey, he should purchase it in the comb. This was true until the passage of the National Pure Food Law, which went into effect January 1, 1907. Just previous to this time extracted honey was not as much adulterated as formerly, due in part to the many state food laws, and also, in greater part, to the fact that chemical methods had advanced to a point where adulterations with glucose, sugar syrup, etc., were easily recognized. Since 1910 all adulterations of honey have practically ceased. One can now be sure that any honey he buys under a label is pure.

In more recent times, from 1924 to 1932, repeated attempts were made to get bills

through Congress that would permit the undeclared use of corn sugar in interstate commerce of package foods. The proponents of these measures contended that inasmuch as cane and beet sugar had this privilege, corn sugar should have the same right. This contention, plausible enough, did not bring out the fact that corn sugar, only half as sweet as cane or beet sugar, would make it impossible for an honest packer to compete with a concern that used a cheaper sugar in its food product. There was no objection to corn sugar if it was properly declared on the package.

Had these bills been passed it would have been possible to adulterate honey with an inferior corn sugar and sold as pure honey, thus bringing back again the evil days of adulterated honey. The beekeepers put up such a mighty protest to their congressmen and senators that the bills in each case failed of passage.

The same interests back of these bills finally induced the then Secretary Hyde of the Hoover administration to issue a ruling permitting such undeclared use of corn sugar in other foods except honey. While honey was protected, all other foods by this ruling on interstate business could be sweetened with an inferior sugar.

This attempt to foist corn sugar on the public was again frustrated by the action of pure food administrations of nearly all the states issuing a counter ruling shutting out the undeclared use of corn sugar from all foods in their respective states.

It appears then that honey is doubly protected not only by the ruling of the United States Secretary of Agriculture, but by the pure food laws and rulings of nearly all the states in the Union. Honey in this respect occupies a unique position among all foods.

Part 6, Bulletin 13, of the Division of Chemistry, U. S. Department of Agriculture (a report of investigations made under direction of Dr. H. W. Wiley about 1890), contains some 75 pages devoted to honey. In this are given numerous analyses of honey. The adulterants noted were glucose, cane sugar, and invert sugar. The number of samples containing glucose was very large. (See Glucose, Cane Sugar, Invert Sugar for descriptions of the substances.)

Adulteration with Invert Sugar

A still more troublesome type of adulteration appeared when invert sugar syrups became commercially available. Invert sugar syrup contains two sugars, levulose and dextrose, in equal proportions, and these are exactly the sugars which occur in different proportions in honey. For this reason it is more difficult to detect such adulteration, yet chemists have devised reliable tests to this purpose. An interesting case of such adulteration was discovered some years ago, and when the culprit was hailed into court he defended himself by claiming that his product was pure honey which had been boiled for a special trade. Again the chemists were three jumps ahead of fraud and they proved that the defense was untrue. This was an interesting race between honesty and dishonesty, with honesty still in the lead.

Invert sugar syrup granulates quickly. Beekeepers once believed that granulation was a test of the purity of honey, and some still put a statement to that effect on their labels. This is, of course, not true. One invert sugar syrup is now manufactured which remains liquid, through the addition of a small amount of gummy material which inhibits the formation of crystals. This added material is not hard to detect, and any beekeeper who tries to use syrup of this kind for his bees in winter will soon find some bad cases of dysentery in his apiary.

Invert sugar syrup was used largely in Germany during the war and was sold under the name "Kunsthonig," artificial honey. German beekeepers protested the use of the word honey for this material and since the war have waged an active warfare against its sale as or in honey. The recent difficulties about the absence of diastase in some American honeys exported to Germany arose from this campaign. This problem seems to have arisen through the use of a large share of the available sugar supply in the manufacture of glycerine, and the remainder was put into the form of invert sugar syrup so that consumers would receive more sweetness than they would from the sugar in its original form.

AFTER-SWARMING. — All swarms that come out after the first swarm, or are led out by a virgin queen or a plurality of them, are generally termed afterswarms; and all swarms after the first are accompanied by such queens. There may be from one all the way up to a half-dozen swarms, depending on the yield

of honey, amount of brood or larvae, number of queens, and the weather; but, whatever the number, they are all led off by queens reared from one lot of queen-cells, and the number of bees accompanying them is, of necessity, less each time. The last ones frequently contain no more than a pint of bees, and, if hived in the old way, would be of little use under almost any circumstances; yet when supplied with combs already built and filled with honey, such as every enlightened apiarist should always keep in store, they may develop into the very best of colonies, for they have young and vigorous queens.

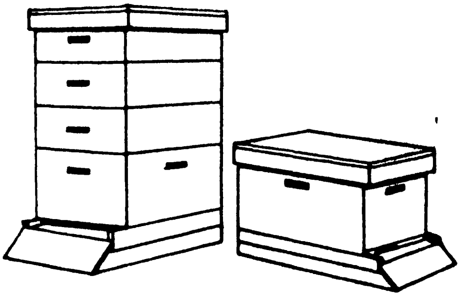
It has been said that when a colony has decided to send out no more swarms, all the young queens in the hive are sent out, or, it may be, allowed to go out with the last one. Whether this is true or not is uncertain; but during the swarming season some novice writes about the wonderful fact of his having found three or four, or it may be half a dozen queens in one swarm. On one occasion a man who weighed something over 200 pounds ascended to the top of an apple tree during a hot July day to hive a small third swarm. He soon came down in breathless haste to say that the swarm was all queens; and, in proof of it, he brought two or three in his closed-up hands.

Years ago after-swarming was considered a sort of necessary evil that had to be tolerated because it could not be obviated; but in no well-regulated apiary should it be allowed. Many consider it good practice to permit one swarm—the first one. After that all others are re-

Introducing cage.

strained. Cutting out all the queen-cells but one may have the effect of preventing a second swarm; but the practice is objectionable—chiefly because one can not be sure that he destroys all but one. If there are two cells not of the same age, the occupant of one of them, when she emerges, is likely to bring out an after-swarm; indeed, as long as there are young queens to emerge, there are likely to be after-swarms up to the number of three or four.

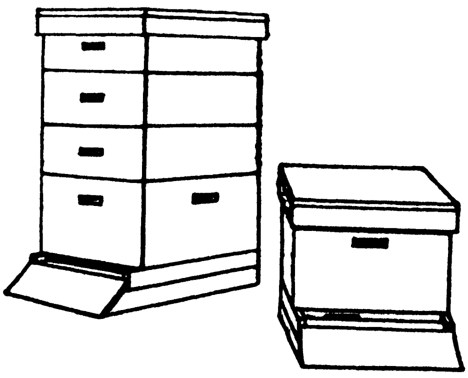
But many practical honey-producers con-



New hive with supers on old stand. Old hive turned aside.

sider cell-cutting for the prevention of these little swarms a waste of time, although they may and do cut out cells to prevent prime or first-swarms. There are some who deem it advisable to prevent swarming. There are two plans for preventing after-swarms, both of which are good:

(1) The wings of all laying queens in the apiary are clipped. (See How to Clip a Queen's Wings, under Queens.) As soon as the first swarm comes forth, and while the bees are in the air, the queen, if clipped, is found in front of the entrance of the old hive. She is caged, and the old hive is lifted off the old stand, and an empty one containing frames of foundation or empty combs is put in its place. A perforated zinc honey-board is then put on top, and on this are placed the supers taken from the old hive. The queen in her cage is placed in front of the entrance, and the old hive is next carried to an entirely new location. In the meantime the swarm returns to find the queen at the old stand; and when the bees are well



Old hive turned back toward new one after swarm has entered.

started to running into the entrance she is released and allowed to go in with them. The old or flying bees left in the old colony, now on the new location, will go back to the old stand to strengthen the swarm. This will so depopulate the parent colony that there will hardly be bees enough left to cause any after-swarming, and the surplus of young queens will have to fight it out among themselves, nature's law, the survival of the fittest, determining the future queen. She will be mated in the regular way, and the few bees with her will not, of course, follow her. In a comparatively short time the parent colony will be strong enough for winter.

(2) The first swarm is allowed to come forth; and while it is in the air the parent colony is removed from its stand and placed a few inches to one side, with its entrance pointing at right angles to its former position. For instance, if the old hive faced the east, it will now look toward the north. Another hive is placed on the old stand, filled with frames of wired foundation. The swarm is put in the hive on the old stand, and at the end of two days the parent hive is turned around so that its entrance points in the same direction as the hive that now has the swarm. Just as soon as young queens of the parent colony are about to emerge, it is carried to a new location during the middle of the day or when the bees are flying thickest. This should be done carefully without disturbing the colony, so the bees in leaving the hive will not mark the new location. Usually this should be done on the seventh or eighth day after the prime swarm issued. The result is, these flying bees will go back to the hive having the swarm.

Old hive set close to new to be moved away on seventh day.

This, like the other method described, so depletes the parent hive that any attempt at after-swarming is effectually forestalled.

The only reason for turning the entrance of the old hive to one side at first is to prevent any of the bees entering it while the swarm is being hived in the new one and until the bees of the new swarm become accustomed to the new order of things. In making artificial swarms it is not necessary to turn the entrance of the old hive away, for in this case there is less danger of the bees of the swarm entering the old hive.

While the second plan gives a larger force of bees to the swarm, it requires more work than the first one. It is the better plan at a home yard or where one can be present.

AGE OF BEES.—It may be rather difficult to decide how long a worker bee would live if kept from wearing itself out by the active labors of the field; six months certainly, and perhaps a year; but the average life during the summer time is not over three months, and perhaps during the height of the clover bloom not over four or six weeks, or five weeks is the average.

Under normal conditions, roughly the first half of the worker's life, or about three weeks, is given over to hive duties and the last half to field duties. The exact sequence, if any, for all of the duties within the hive has yet to be set forth. Thus, although it is commonly accepted that younger bees function as nurses, the relative ages at which such duties as guarding, carrying out debris, taking incoming nectar from field bees, and stowing away pollen are performed, have remained unknown. To G. A. Rosch, who has been working with Prof. Dr. von Frisch, of Germany, goes credit for throwing more light on these four duties as well as furnishing interesting details on the nursing period. One difficulty in this field has been that of so marking a sufficient quantity of bees in any particular colony that each bee could be recognized individually throughout its life. This difficulty was overcome by using the method mentioned by von Frisch in his paper of 1920 when he first made public his work on the

"dances" of the workers. The hive used by Rosch consisted of several frames so arranged that each side of each frame was exposed to view through glass. The work published covers results obtained in three successive years beginning in 1922.

In general Rosch confirms earlier conceptions that, under normal conditions, about the first three weeks is given over to hive duties, and the remainder of life to field duties. He found the average duration of the worker's life in the busiest period of the year to be about five weeks. The period of hive duties is divided into two parts, the first of which begins with three days devoted to cleaning out cells for the queen to lay in and is followed by about ten days given over to nursing larvae. The second part of the period of hive duties, about a week, if nursing continues until the thirteenth day, is a period of varying hive duties, such as guarding, stowing away pollen, carrying out debris, and the like.

No hard and fast time limits are given for any duties, since, with the exception of the first three days, an excess of bees for any one activity may lead to this excess performing other duties, and vice versa. For the first three days, however, the only work performed by the worker after cleaning its body on emergence and getting food from other bees, is to clean out brood-cells. In the course of the process the cell is "licked" with the tongue, and this apparently leaves an odor since the queen was observed to pass over all cells not so treated. Several different bees or even the same bee may visit a cell in succession; but no worker was seen to be the first to clean out the cell from which she had emerged, others usually entering while she was cleaning herself up. These young bees were never seen to gnaw down any capping left on brood cells. This duty remains for older bees. During the first two or three days young workers were never seen helping themselves to any food stored in the hive. After cleaning cells for a time, they would often remain apparently idling on sealed or unsealed brood. This, together with the fact that bees of such an age appear unable to do anything but clean cells, is of prime importance, according to Rosch, because it serves to keep the brood warm. No other bees could do it so well because their duties take them away from the brood in the busy season.

One of the most important findings by Rosch, if confirmed, tends to further clear up the presence of honey and pollen in the food of worker larvae after the third day. He presents data from histological studies showing that the pharyngeal glands, which secrete larval food, are not completely developed until three to six days after emergence of the worker, and that by the fifteenth day their degeneration is under way. In line with this, he found bees during their first two or three days as nurses, immediately after serving as brood-cell cleaners, taking both stored honey and pollen and then feeding larvae which in no case were more than two days from being sealed in. According to his histological studies, the glands of such bees would not be developed sufficiently to secrete larval food. As a matter of fact, he states that the younger larvae were never fed by workers younger than five days. These older nurses, in addition, gave some food to the older larvae.

Orientation flights may begin in the latter part of the nursing period. This period itself, says Rosch, may extend slightly beyond the thirteenth day in case of lack of nurse bees. On the other hand, it may be cut short by a heavy honey flow, since the last period of hive duties begins by relieving incoming nectar-gatherers of their load and storing it away. Stowing away pollen, which the gatherers merely kick off in the cells, is performed at this age also. Once these duties were begun, the brood was left to others. Longer orientation flights were observed at this time. Since bees so commonly fly a little distance from the hive with debris, Rosch holds that they do not become debris removers until they have made enough orientation flights to find their way back to the hive. Thus he explains why older bees dispose of cappings from brood-cells. Guarding was found to be one of the last duties before taking to the field. Rosch observed an individual bee on guard for three successive days. He did not find any definite sequence in field duties, nor did he find the first field trip caused by any "dance."

During the summer months, the life of the worker bee is cut short by the wearing-out of its wings, and at the close of a warm day hundreds of these heavily laden, ragged-winged veterans will be

found making their way into the hives slowly and painfully, as compared with the nimble and perfect-winged young bees. If the ground around the apiary be examined at nightfall, numbers of these old bees may be seen hopping about, evidently recognizing their own inability to be of any further use to the community. The author has repeatedly picked them up and placed them in the entrance, but they usually seem bent only on crawling and hopping off out of the way where they can die without hindering the teeming rising generation. During the height of a honey flow workers probably do not live more than six weeks.

Age of Drones

It is somewhat difficult to decide upon the age of drones, because the poor fellows are so often hustled out of the way for the simple reason that they are no longer wanted (see Drones); but it may be assumed to be something less than the age of a worker. If kept constantly in a queenless hive they might live for three of four months. Occasionally some live over winter, from September to April.

Age of the Queen

As the queen seldom if ever leaves the hive except at mating and at swarming time, one would naturally expect her to live to a good old age, and this she does, despite her arduous egg-laying duties. Some queens die, seemingly of old age, the second season; but generally they live through the second or third, and they have been known to lay very well even during the fourth year. They are seldom profitable after the second year, and the Italians will sometimes have a young queen "helping" mother before the beekeeper recognizes the old queen as a failing one. Many and perhaps most beekeepers think it profitable to requeen yearly. A young queen, as a rule, will keep a colony more populous than an old one. A large force of bees in a honey flow is much more profitable than a light force. It pays well to requeen.

Bibliography: V. C. Milum, Champaign, Ill. "The Honeybee's Span of Life." 1931.

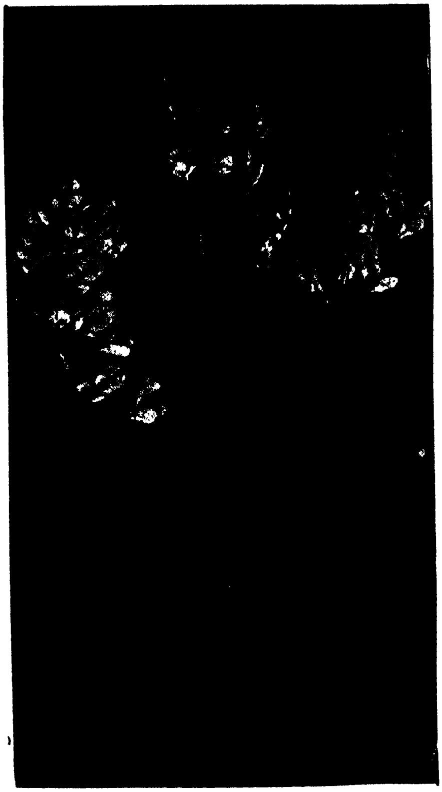
ALFALFA *(Medicago sativa* L.).—Alfalfa belongs to the pulse family, or *Leguminosae,* which includes more than 5,000 species. (See "Honey Plants of North America.")

The culture of the plant has become established in every state in the Union and every province in Canada. Its claim to the attention of beekeepers lies in its extreme importance as a honey plant in the West, and to an increasing extent in the East. To discuss alfalfa from the standpoint of the beekeeper, this article will first consider the nature of alfalfa honey; second, alfalfa as bee pasturage.

Alfalfa Honey

Most alfalfa honey has a pleasant slightly minty taste. The best alfalfa honey, thick, rich, and delicious, has proved a favorite with the public where the honey can be eaten before granulation commences. Although difficult to handle on that account, dealers hesitate to discard so well-flavored an article. It runs 12 to 13 pounds to the gallon while other honeys seldom exceed 12 pounds.

A marked characteristic of alfalfa honey is its tendency to granulate, especially that from certain localities. In examining a given lot of alfalfa honey it is impossible to say when granulation will be likely to set in. If kept in a warm room



Alfalfa blossom.

Alfalfa (Medicago sativa L.)

some alfalfa honey will continue liquid for an entire season; but, on the other hand, it may be solid in a very few weeks. When granulated it is fine and creamy; hence it is often retailed in the solid form in cartons. (See Granulated Honey.)

In tests conducted by the Bureau of Chemistry, Washington, D. C., alfalfa samples shown to be purer than the others (that is freer from other honeys) granulated solid. The statement has been made that pure alfalfa honey will scarcely granulate at all, and that when it solidifies early it is mixed with honey from wild flowers. In view, however, of the uniform granulation of samples of known purity tested by the government, this statement is apparently not generally true.

Alfalfa as a Honey Plant

Next to sweet clover, alfalfa is probably the greatest source of carload production of honey in the United States. As a rule, alfalfa and sweet clover are grown in the same localities in the West, and much of the so-called alfalfa honey is alfalfa and sweet clover mixed. The production some years from the Rocky Mountain States reaches a thousand cars.

Alfalfa in the East

It was formerly supposed that alfalfa would not produce honey outside of the irrigated regions of the West, and while it is true that irrigated alfalfa will produce much more honey per acre than that grown on land not irrigated, the facts are accumulating, showing that the plant does yield some honey in what are called the dry farming states. Even in the East, or what is called the rain belt, alfalfa will, some seasons and in some localities, yield some honey.

There is a variety of alfalfa called Grimm that is being grown quite extensively in many of the eastern states. This yields considerable honey.

At one of the author's yards in northwestern Ohio the bees gathered considerable of what he believes was alfalfa honey after sweet clover was out of bloom and dried up. A check has shown that the bees were on the alfalfa on the first, second and third cutting, and from such fields were gathered a large amount of seed.

It should be noted, however, that acre for acre, sweet clover in these eastern states will yield much more honey than alfalfa.

In some of the eastern territory there is a tendency on the part of the farmers to let sweet clover run out for alfalfa because the former is a biennial and must be replanted, and the latter is a perennial and does not have to be reseeded. While alfalfa will yield a better hay than sweet clover, it is not as good for improving the soil nor does it furnish as good pasture for cattle. As a plow-under crop, sweet clover furnishes a better humus and it is much easier to plow under. (See Sweet Clover.)

Alfalfa in the West

The great bulk of alfalfa honey is produced in the Rocky Mountain regions, reaching all the way from the northern to the southern border of the country. In the elevated regions of the more northern states, Colorado, Montana, and Wyoming, the honey is light-colored and of heavy body, the color ranging from a white to almost water-white. In the more southern states, southern California, Arizona, and New Mexico, the honey, while of good quality, is on the amber order. In central-northern California the alfalfa is of good quality, but along the coast little or no nectar is yielded by the plant.

In many of the localities where alfalfa yields well the crop of nectar or honey is cut short when the alfalfa is cut. In some localities the rule is to cut the alfalfa when one-tenth of the bloom is out, because it is said that there is more milk in the plant at this stage of its growth. For the last 20 years the practice has been to cut when about one-half of the plants are in bloom. As a rule, the farmers (fortunately for the beekeepers) are behind in their cutting. Some of them feel that it is better to err on the side of cutting too late than too early.

Where alfalfa is grown for seed the beekeepers secure a rich harvest of honey. These localities, however, are rather scarce. Consequently the alfalfa honey producers must depend mainly upon the plants that have reached the stage of medium bloom.

The Number of Cuttings Per Season

The number of cuttings of alfalfa per season varies from two to six. In irrigated country the cuttings are greater and the amount of hay per cut is greater than in the eastern section of the country. In the West the alfalfa will reach a height, when ready to cut, from three to four feet. In the East, it seldom reaches above a foot. In short, it is in the irrigated re-

THE CELEBRATED ALFALFA PLANT AND ROOT.

The plant represented in this plate grew in rich, loose soil, with a heavy clay subsoil and an abundant supply of water, the water level ranging from 4 to 8 feet from the surface at different seasons of the year. The diameter at the top was 18 inches and the number of stems 360. The plate shows how these crowns gather soil around them, for the length of the underground stems is seen to be several inches, and this represents the accumulation of nearly this much material about it.

This is one of the largest plants that I have yet found. The specimen, as photographed, was dug April 30, 1896.—Dr. Headden, in Bulletin No. 35, "Alfalfa."

gions where the soil is deep and rich that alfalfa is at its best both for hay and honey. It likes wet feet and always a sweet, soil, either west or east.

Increase in Acreage

Both alfalfa and sweet clover are increasing in acreage by leaps and bounds. A few years ago there was no alfalfa or sweet clover in North or South Dakota. The same can be said of Montana and Wyoming. Now these four states rank among the leading states in the production of alfalfa and sweet clover. However, only a very small per cent of the honey produced in Wyoming is obtained from alfalfa, according to C. L. Corkins; and we know this to be true in some other localities where alfalfa is grown quite extensively.

Time of Cutting

In regard to the time of cutting alfalfa in Colorado, Alvin Kezer, Chief Agronomist of that state, writes:

There is some dispute among farmers and others as to the best time and method of cutting and putting up alfalfa hay. Experiments which have been conducted in Kansas show that, under Kansas conditions, it is much better for the life of an alfalfa field to cut the alfalfa when practically in full bloom than to cut in earlier stages of growth. I have been on the experimental fields at the Kansas station and know that, so far as the life of the alfalfa fields is concerned — that is, so far as the number of years which a field will live and produce well is concerned—under their non-irrigated conditions they get better results cutting at or nearly at full bloom.

We have in Colorado in most of our territory quite a different situation. We supply water by irrigation. Due to certain diseases that have been prevalent the last few years, the life of an alfalfa field is relatively short anyway, so it is up to the grower to get the highest tonnage of the best quality hay possible. The proper time to cut can not always be determined by the state of the bloom, because weather conditions influence the state of bloom remarkably. The bloom will come out at a younger stage in bright, warm, sunshiny weather than when the weather is moist, cool, and cloudy. In general, however, under our short-season conditions we can get the best quality of hay and the best tonnage by cutting when about one-fourth of the crop is in bloom. Under our irrigated conditions the crop is ready to cut when the shoots which are to produce the next crop appear and have made a growth of an inch or two. Our seasons are short, so it is up to us to get as much out of the second and third cuttings as possible. The earlier we make the first cutting the longer growth-period we have for the second and third cuttings. In bright weather the bloom is a very good indication of the time to cut; but in very cool, moist, and cloudy weather cutting should often be done considerably in advance of the usual stage of bloom at which cutting is done.

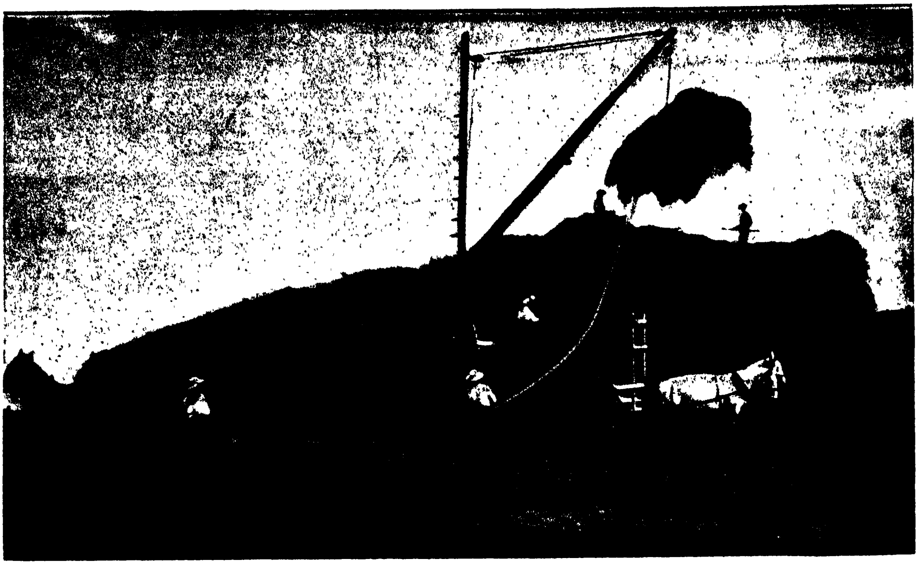
If the hay, especially the first cutting, is allowed to go to full bloom it is apt to be too stemmy for dairy animals. If it is allowed to get to half bloom it makes a very excellent quality of hay. If it is allowed to go past full bloom it shortens the period for the succeeding crops and thus reduces the total annual yield. The biggest yield per cutting can be obtained by allowing the crop to go to full bloom or slightly past full bloom, but in our short seasons that does not always mean the biggest tonnage per year.

A much more mature hay is advisable for horses or for fattening animals than is advisable for dairy animals, and this feature must be duly considered in choosing the time to cut. Hay for dairy animals should be cut at a little earlier stage of bloom than horse hay or feeding hay for fattening animals.

Method of stacking alfalfa hay.

Pollination

The form of the flower is papilionaceous, or butterfly-shaped, bearing a general resemblance to the flower of the garden pea. The manner of pollination is of great interest both to beekeepers and seed-growers. The flowers are known as explosive flowers. The anthers and stigma are held in the keel under elastic tension, which resides in the staminal collumn formed by the union of filaments of 9 of the 10 stamens. When a bee presses down the wings and keel, says Burkill, it pulls two triggers and fires off the flower; that is, the two processes which restrain the staminal column in the carina separate, and permit the stamens and pistil to fly forcibly upward, bringing the pollen in contact with the under side of the bee's body. A slight clicking sound may some-



An alfalfa haystack on a 5,000-acre farm assumes enormous proportions.

times be heard when the stigma strikes against the standard, and a little cloud of pollen is visible. The stigma stands a little in advance of the anthers, and strikes the pollen-brush of the bee first; if the latter is covered with pollen from another flower, previously visited, cross-pollination is effected. Both of these organs then move upward against the erect petal called the standard, where they are out of the way, and do not again come in contact with insects. A single normal visit is sufficient to effect pollination, and all subsequent visits are useless. However, after the flowers have been exploded, or "tripped," they continue to secrete nectar and receive insect visits. This is clearly an imperfection, since the attraction of visitors is no longer an advantage.

In different seasons and different localities there is a wide difference in the quantity of seed produced by alfalfa. In the Milk River Valley of Montana a yield of from 10 to 12 bushels per acre has been obtained in favorable years, while in others it was almost a complete failure. Contradictory assertions have been repeatedly made by various observers that the flowers are self-fertile or self-sterile in the absence of insects. For the purpose of settling this question definitely, numerous experiments were conducted by Piper and his assistants, the results of which were published by the Bureau of Plant Industry in 1914.

More than 24 species of wild bees, besides many butterflies, flies, and beetles, have been observed on the flowers; but many of these are useless as pollinators. In localities where alfalfa is nectarless it is almost entirely ignored by honeybees, but where it secretes nectar freely they are attracted in great numbers.

It is now well established that the production of seed is greatly influenced by climate and by large apiaries of honeybees. Practical experience has shown that it can be raised in paying quantities only in those states which possess a hot, dry season. Too much moisture is injurious, and consequently the eastern portion of the country with its larger rainfall is not well adapted for this purpose; while in the irrigated sections one irrigation is usually omitted. It is of interest to beekeepers to know that most of the seed is raised in Arizona, California, Utah, Colorado, Kansas, and Idaho. The best results are obtained with a thin stand of alfalfa, or where it is cultivated in rows. The domestic supply is far below the demand, and millions of pounds are annually imported.

Authorities

While certain general principles can be laid down regarding alfalfa for all parts

of the United States, it has not been possible in this article to go into those local details with which the well-informed grower should be familiar. Any one interested in the plant should first find out what his state experiment station has published on alfalfa-growing in his locality. The literature is thorough and comprehensive.

One of the best works on the subject is J. E. Wing's "Alfalfa in America" (1912). A somewhat more extensive work is F. D. Coburn's "The Book of Alfalfa" (1912). The Department of Agriculture, Washington, publishes Farmers' Bulletin No. 339, entitled "Alfalfa," by J. M. Westgate. Of the various publications by state experiment stations, those by the Colorado, Illinois, Utah, Ohio, and Kentucky stations are especially valuable. All of the works cited were used in the preparation of this article.

ALGAROBA.—See Mesquite.

ALSIKE CLOVER.—See Clover.

ALUMINUM COMBS. — See Metal Combs.

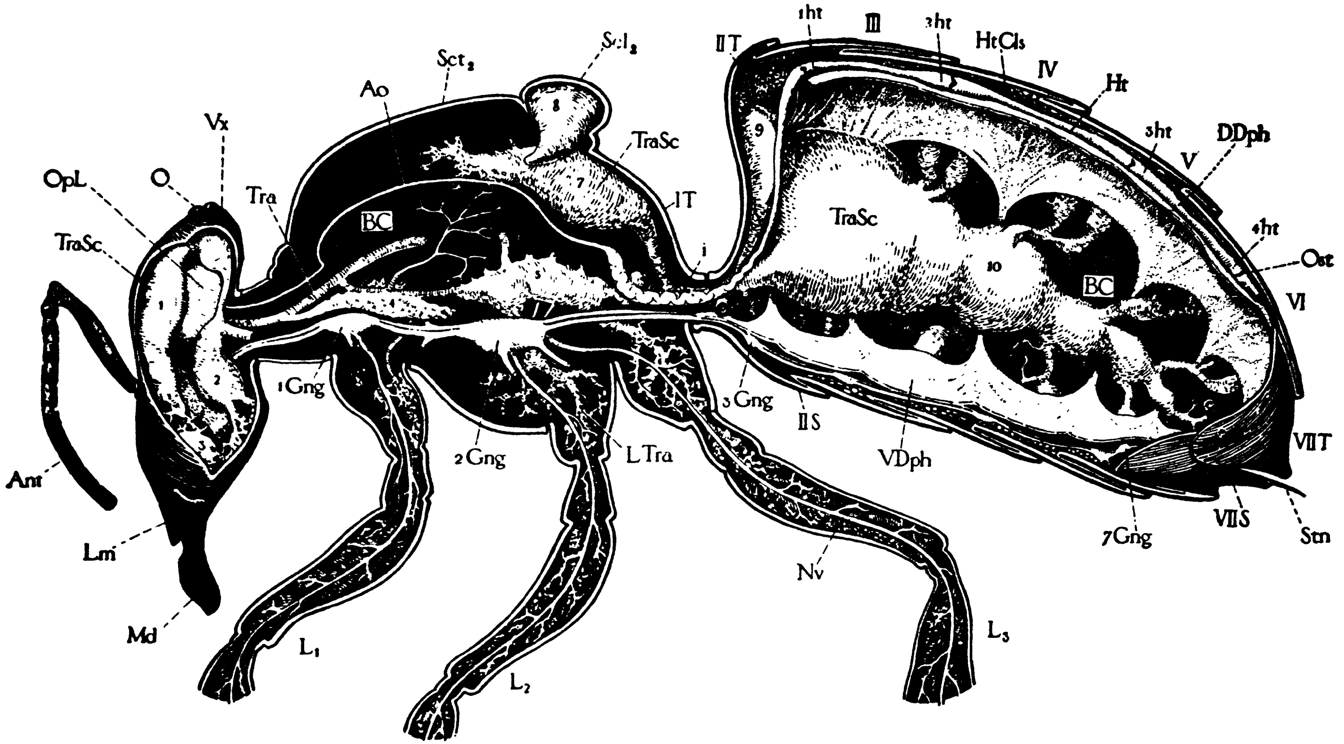
AMATEUR BEEKEEPING. — See Back-lot Beekeeping; also A B C of Beekeeping.

ANATOMY OF THE BEE.—The three parts of the body of the bee are well separated by constrictions. The head carries the eyes, antennae, and mouth parts; the thorax, the wings, and legs; and the abdomen, the wax-glands and sting.

The *head* is flattened and triangular, being widest crosswise through the upper corners, which are capped by the large compound eyes. It carries the *antennae*, or feelers, on the middle of the face (Fig. 2, A, *Ant)*; the large *compound eyes (E)* laterally; three small simple eyes or *ocelli (O)*, at the top of the face, and the *mouth parts (Md, Mx,* and *Lb)* ventrally. Each antenna consists of a long basal joint and a series of small ones hanging downward from the end of the first. The antennae are very sensitive to touch, and contain the organs of smell. At the lower edge of the face is a loose flap (Fig. 2, A, *Lm)* forming an upper lip called the *labrum.* On its under surface is a small soft lobe called the *epipharynx* on which are located the organs of taste. At the sides of the labrum are the two heavy jaws, or *mandibles (Md)*, which work sidewise. They are spoon-shaped at their ends in the worker, but sharp-pointed and toothed in the queen and drone. Those of the queen are largest, those of the drone smallest. Behind the labrum and the mandibles is a bunch of long appendages, usually folded back beneath the head, which together constitute the *proboscis* (Fig. 2, A, *Prb.)* These organs correspond with the second pair of jaws, or *maxillaea*, and the lower lip, or *labium*, of other insects. In Fig. 2 they are cut off a short distance from the head and flattened out in Fig. 3, D. The middle series of pieces *(Smt-Lbl)* constitute the labium, the two lateral series *(Cd-Mx)* the maxillae. The labium consists of a basal *submentum (Smt)*, and *a mentum (Mt)*, which supports distally the slender flexible, tongue-like *glossa (Gls)*, the two delicate *paraglossae (Pgl)*, and the two lateral, jointed labial palpi *(LbPlp)*. Each maxilla is composed of a basal stalk, the *cardo (Cd)*; a main plate, the *stipes (St)*, and a wide terminal blade *(Mx)* called the *galea.* At the base of the galea is a rudimentary *maxillary palpus (MxPlp)*, representing a part which in most insects consists of several slender joints.

As before stated, the parts of the maxillae and the labium together constitute the proboscis, which as shown in Fig. 2, B, is

[Perhaps the average beekeeper would feel that he would care little or nothing about reading of the structure of the honeybees by Snodgrass, formerly with the Bureau of Entomology, Washington, D. C., and author of the book. "Anatomy and Physiology of the Honey Bee," a work of over 300 pages. Such a reading will enable him to understand many things in the general management of bees that might otherwise be somewhat obscure. He will find that, while there are similarities between the structure of a honeybee and a highly organized human being, there are some marked differences. In the case of the former the skeleton is on the outside and serves as a protector to the softer parts within. In the case of the latter the skeleton is on the inside and covered by the softer parts of the outside. In the bee the blood is aerated by having the lung portion extended clear through the whole structure of the bee. In the case of the human being the lung portion is confined to the upper part of the chest and the blood is aerated by being pumped through the body and then through the lungs and back again through the general system. In the bee we find the honey stomach and the stomach mouth, which are not found in any of the vertebrates. We likewise find a sting, a highly organized weapon of offense and defense, a sense of smell that is very acute, a tongue and mouth parts that are very different from anything we find in any animal or human being. In the insect the body is divided into three parts; in the animal there is no such division. With this understanding it is hoped that the reader will find it easy to go through the description now given by the greatest authority in all the world on the anatomy of honeybees, namely, Mr. R. E. Snodgrass.—Editor.]



From Bulletin No. 18, "The Anatomy of the Honeybee," by Snodgrass, Department of Agriculture, Washington, D. C.

Fig. 1.—Longitudinal median, vertical section of worker, exposing body cavity (BC) in right side, with alimentary canal (Fig. 6) removed, but showing tracheal system (Tra, LTra, and Tra Ss 1-10), heart (Ht), and aorta (Ao); dorsal diaphragm (DDph), ventral diaphragm (VDph), and nervous system (OpL, 1 Gng-7Gng). Ao,, aorta; Ant, antenna; BC, body cavity; DDph, dorsal diaphragm; Gnd, ganglion; 1Gng, 2Gng, first and second thoracic ganglia; 3Gng-7Gng, abdominal ganglia; Ht, heart; 1ht 4ht, chambers of heart; i, convolutions of aorta; L, leg; L1, L2, L3, prothoracic, mesothoracic, and metathoracic legs; Lm, labrum; LTra, trachea of leg; Md, mandible; Nv, nerve (of leg); O, ocelli; OpL, optic lobe of brain; Ost, ostium (aperature of heart); S. Sternum; IIS-VIIS, second to seventh abdominal sterna; Sct 2, scutellum of mesothorax; Stn, sting; Tra, trachea; TraSc (1-10), tracheal air-sacs; T, tergum; It, propodeum, or first abdominal tergum; VIIT, seventh abdominal tergum; VDph, ventral tergum; Vx, vertex.

suspended from a deep cavity *(PrbFs)* on the lower part of the back of the head having a membranous floor. The nasal stalks *(Cd)* of the maxillae are hinged to knobs on the sides of this cavity, while the labium is attached to the maxillary stalks by means of a flexible band called the *lorum* (Fig. 3, D, *Lr)*.

When the bee wishes to suck up any liquid, especially a thick liquid like honey or syrup, provided in considerable quantity, the terminal lobes of the labium and maxillae are pressed close together so as to make a tube between them. The labium is then moved back and forth between the maxillae with a pump-like motion produced by muscles within the head. This brings the liquid up to the mouth, which is situated above the base of the proboscis, between the mandibles and beneath the labrum. The food is then taken into the mouth by a sucking action of the pharynx, produced by its muscles.

A more delicate apparatus is probably necessary, however, for sucking up minute drops of nectar from the bottom of a flower. Such a structure is provided within the glossa. This organ (Fig. 3, D, *Gls)*, ordinarily called the "tongue," is terminated by a delicate, sensitive, spoonlike lobe known as the labella (Fig. 3, A, B, and D, *Lbl)*, and has a groove *(k)* running along its entire length on the ventral side. Within the glossa this groove expands into a double-barrel tube (Fig. 3, E, *Lum)*. A flexible chitinous rod *(r)* lies along the dorsal wall of this channel, which is itself provided with a still finer groove *(l)* along its ventral surface. Thus the very smallest quantity of nectar may find a channel suited to its bulk through which it may run up to the base of the glossa by capillary attraction. But since the glossal channels are ventral the nectar must be transferred to the dorsal side of the labium by means of the paraglossae, the two soft lobes (Fig. 3, D and F, *Pgl)*, whose bases are on the upper side of the mentum, but whose distal ends underlap the base of the glossa, and thus afford conduits for the nectar around the latter to the upper side of the labium. The glossa is highly extensible and retractile by means of muscles attached to the base of the rod, and its movements when a bee is feeding are very conspicuous, and interesting to watch.

The *thorax* of an insect carries the wings and the legs. The two wings of the bee on each side are united to each other by a series of minute hooks so that they work together, and the four wings are thus practically converted into two. Each wing is hinged at its base to the back, and pivoted from below upon a small knob of the side wall of the thorax. The up-and-down motion of the wings is produced, not by muscles attached to their bases, but by two sets of enormous muscles, one vertical and the other horizontal, attached to the walls of the thorax, whose contractions elevate and depress the back plates of the thorax. Since the fulcrum of each wing is outside of its attachment to the back, the depression of the latter elevates the wing, and an elevation of the back lowers the wing. But the bee flies by a propellerlike action, or figure-8 motion of the wings. This is produced by two other sets of much smaller muscles acting directly upon the wing bases, one before and the other behind the fulcrum of each. The combined result of all these muscles is that the down stroke of the wing is accompanied by a forward movement and a deflection of the anterior edges, while the up stroke reverses this.

The legs of the bee, in connection with pollen-collecting and pollen-carrying, are described by Casteel under the head of "Pollen." Their especial characters, such as the antennae-cleaners on the first and pollen-basket and brushes on the last, are illustrated in Fig. 4. The tarsi are each provided with a pair of terminal *claws (E, Cla)*, by means of which the bee clings to rough objects, while between the claws is a sticky pad, the *empodium (Emp)*, which is brought into play when the bee alights on or walks over any smooth surface like glass.

The hind part of the thorax of bees, wasps, and their allies is composed of a segment which, in other insects, is a part of the abdomen. It is known as the *propodeum*. The middle division of the body of a bee, wasp, or ant, therefore, is not exactly the equivalent of the thorax of a grasshopper, fly, or butterfly.

The abdomen of the bee has no appendages corresponding with those of the head or thorax; but it bears two important organs, viz., the wax glands and the sting. The *wax glands* are simply specially developed cells of the skin on the ventral surfaces of the last four visible abdominal segments of the worker. There are only six segments visible in the apparent abdomen; but, remembering that the propodeum of the thorax is really the first, the wax glands

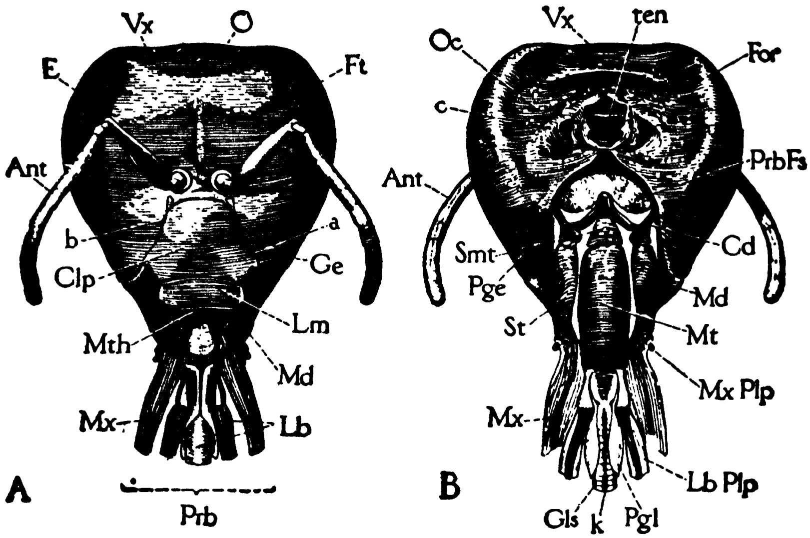


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Fig. 2.—Head of worker with parts of proboscis cut off a short distance from their bases. A, anterior; B, posterior; a, clypeal suture; Ant, antenna; b, pit in clypeal suture marking anterior end of internal bar of head; c, pit on occipital surface of head, marking posterior end of internal bar; Cd, cardo; Clp, clypeus; E, compound eye; For, foramen magnum; Ft, front; Ge, gena; Gls, glossa, or "tongue"; k, ventral groove of glossa; Lb, labium; LbPlp, labial palpus; Lm, labrum; Md, mandible; Mt, mentum; Mth, mouth; Mx, terminal blade of maxilla; MxPlp, maxillary palpus; O, ocelli; Oc, occiput; Pge, postgena; Pgl, paraglossa; Prb, base of proboscis; PrbFs, fossa of proboscis; Smt, submentum; St, stipes; ten, small bar of tentorium arching over foramen magnum; Vx, vertex.

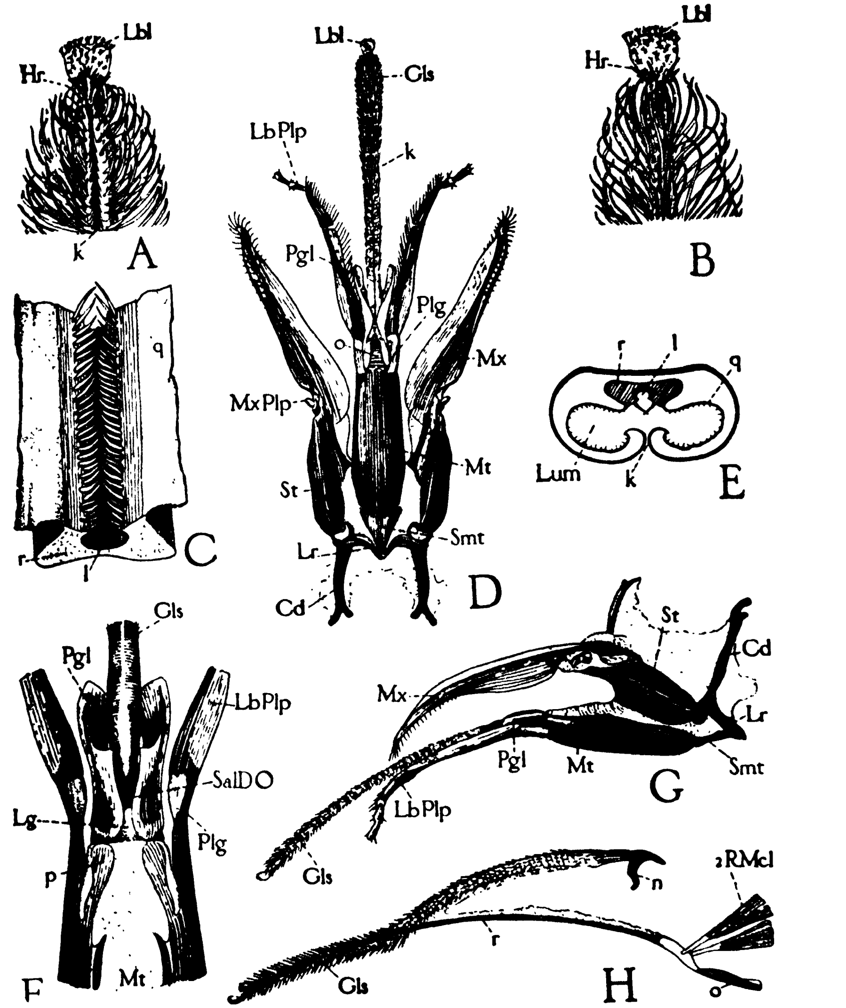
occur, therefore, on segments four to seven inclusive, (Fig. 1, *IV-VII*). The wax secreted by the glands is discharged through minute pores in the ventral plate of each segment, and accumulates in the form of a little scale in the pocket above the underlapping ventral plate of the segment next in front.

The *sting* is such a complicated organ that it is difficult to describe it clearly in a few words. Fundamentally it consists of three slender, closely appressed pieces forming the sharp piercing organ that projects from the tip of the abdomen (Fig. 1, *Stn*), and of two soft fingerlike lobes, sometimes also visible, all of which arise from three pairs of plates belonging to the eighth and ninth segments of the abdomen, but which are concealed within the seventh segment.

Fig. 5 shows, somewhat diagrammatically, all the parts of the left side. The acute stinging shaft swells basally into a large bulb *(ShB)* which is connected by a basal arm on each side with two lateral plates *(Ob and Tri)*. The fingerlike lobes, called the *papli of the sting (StnPlp)* are carried also by the lower of these two plates *(Ob)* while the upper *(Tri)* carries the third and largest plate *(Qd) which partially* overlaps the lower *(Ob)*.

A close examination of the sting proper shows that both the bulb and the tapering shaft are formed of three pieces. One is dorsal *(ShB* and *ShS)* while the other two *(Lct)* are ventral (of course only one of the latter shows in side view). Furthermore, the basal arm on each side is formed of two pieces, one of which *(ShA)* is continuous with the dorsal piece of the sting, while the other *(Lct)* is continuous with the ventral rod of the same side. Since these ventral rods are partially enclosed within a hollow on the underside of the dorsal piece, the latter is called the *sheath of the sting*. It consists of the terminal *shaft* of the sheath *(ShS)*, the *bulb (ShB)*, and of a *basal arm (ShA)* on each side. The ventral pieces *(Lct)* are slender sharp-pointed rods having barbed extremities, and are known as the *lancets*. The shaft of the sheath is grooved along the entire length of its ventral surface, the groove enlarging into a spacious cavity in the bulb. The lancets lie close together against the ventral edges of the sheath, but slide freely

upon minute tracks of the latter. The three parts, therefore, inclose between them a cavity which is tubular in the shaft, but enlarged into a wide chamber in the bulb. The great poison-sac (Fig. 8, *PsnSc)* of the acid glands of the sting opens into the base of the bulb along with the smaller tubular alkaline gland *(BGl)*. By movements of the triangular plates (Fig. 5, *Tri)* the lancets slide back and forth against the sheath while the poison exudes in tiny drops from an opening between them near



From Bulletin No. 18, "The Anatomy of the Honeybee," by Snodgrass, Department of Agriculture, Washington. D. C.

Fig. 3.—Details of mouth parts of worker. A, tip of glossa. ventral; B, tip of glossa, dorsal; C, piece of glossal rod (r) showing ventral groove (l) with parts of wall (q) of glossal channel attached; D, parts of proboscis (maxilla and labium) flattened out in ventral view; E, cross-section of glossa, showing its channel (Lum) open below along the groove (k), the internal rod (r) in roof of channel, and its groove (l); F, distal end of mentum (Mt), dorsal, showing opening of salivary duct (SalDO) on base of ligula; G, lateral view of left half of proboscis; H, glossa (Gls) with its rod (r) partly torn away, showing retractor muscles (2RMcl) attached to its base; Cd, cardo; Hr, long stiff hairs near tip of glossa; k, ventral groove of glossa; l, ventral groove of glossal rod; Lbl, labella; LbPhlp, labial palpus; Lg, ligula; Lr, lorum; Lum, channel in glossa; Mt, mentum; Mx, terminal blade of maxilla; MxPlp, maxillary palpus; n, basal process of glossal rod; o, ventral plate of ligula, carrying base of glossal rod; p, dorsal plates of mentum; Pgl, paraglossa; Plg, palpiger; q, inner wall of glossal channel; r, rod of glossa; 2RMcl, retractor muscle of glossal rod; SalDO, opening of salivary duct; Smt, submentum; St, Stipes.

the tips. The poison-sac has no muscles in its walls, and, hence, can not force the poison through the sting. The poison, in fact, is driven out of the latter by a force pump inside of the bulb. This consists of two pouchlike lobes situated on the upper edges of the lancets, having their cavities open posteriorly. When the lancets move forward the walls of these pouches collapse; but when the motion is reversed they flare apart and drive the poison contained in the bulb back through the shaft and out at the end.

The *poison* is an acid liquid formed by the glands (Fig. 8, *AGl*, *AGl*, and *BGl*). Two of these *(AGl* and *AGl) are simply* small enlargements at the ends of two long coiled tubes *(AGlD)*, which latter unite into a short single tube that opens into the anterior end of the great poison-sac *(Psn Sc)*. The secretion of these glands is acid. The third gland *(BGl)* is a short, somewhat twisted tube opening into the bulb of the sting along with the poison-sac. Its secretion is alkaline. Carlet has shown that it is only the mixture of these two secretions that has the full strength in stinging properties.

The alimentary canal (Fig. 6) consists of a tube extending through the entire body, and coiled somewhat in the abdomen. The first part above the mouth in the head is widened to form the *pharynx (Phy)*. Then follows the long slender *oesophagus (OE)*, running clear through the thorax and into the front of the abdomen, where it enlarges into a thin-walled bag, called, in general, the *crop*, but which is known as the *honey-stomach* (*HS*) in the bee. Back of the honey-stomach is a short narrow *proventriculus (Pvent)*, which is followed by the large U-shaped stomach, or *ventriculus (Vent)*. Then comes the slender *small* intestine *(SInt)* with a circle of *Malpighian tubules (Mal)* arising from its interior end. Finally, forming the terminal part of the alimentary canal, is the *large* intestine, or *rectum* (*Rect*), consisting of an enormous sac, varying in size according to its contents, but often occupying a large part of the abdominal cavity. Six opaque longitudinal bands on its interior end are known as the *rectal glands (RGl)*.

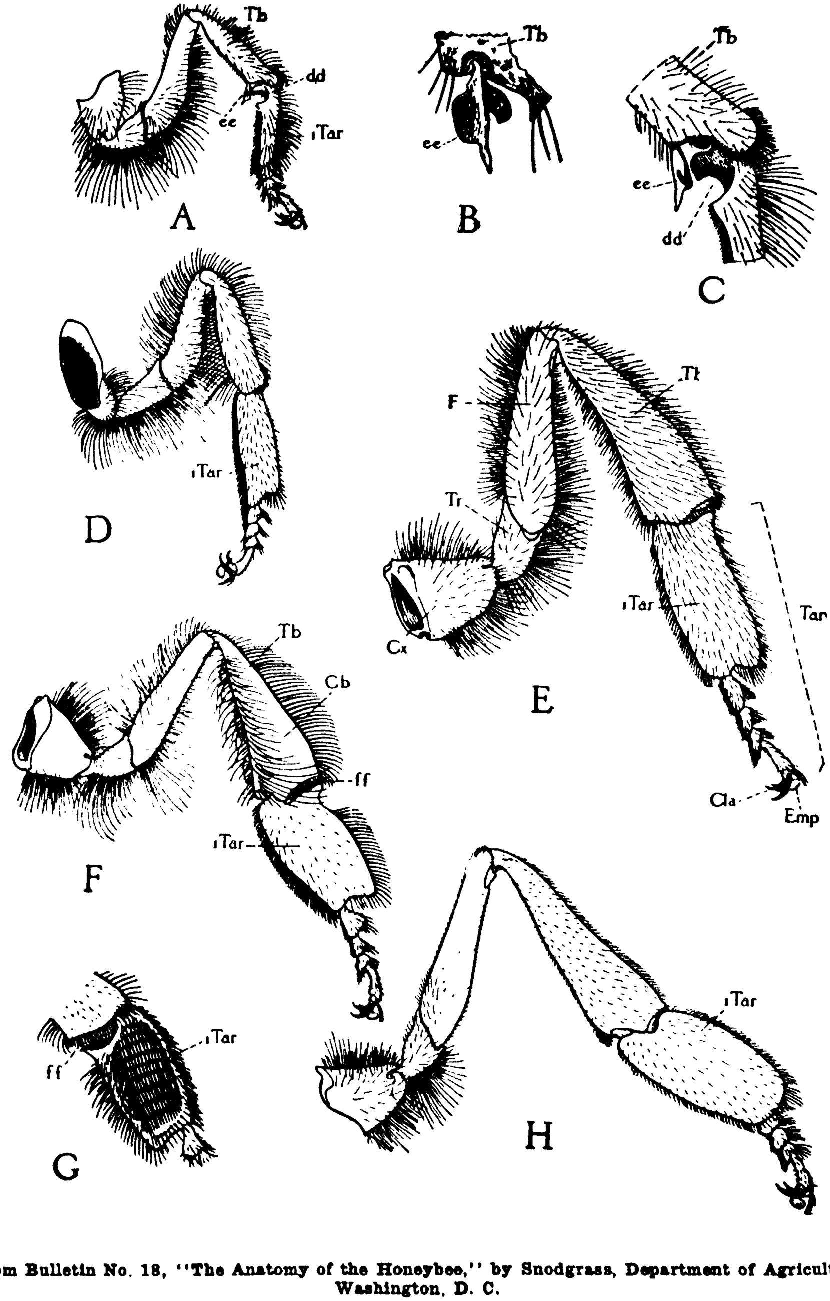
The honey stomach is of special interest in the worker because the nectar gathered from the flowers is held in it, instead of being swallowed on down into the stomach, and is regurgitated into the cells of the comb, or given up first to another bee in the hive. The upper end of the proventriculus sticks up into the lower end of the honey-stomach as a small cone with an X-shaped opening in its summit. This opening is called the *stomach mouth.* Its four lips are very active, and take whatever food the ventriculus requires from the honey-stomach, for it must all go into the latter first, while at the same time it affords the bees a means of retaining nectar or honey in the honey-stomach.

The natural food of bees consists of pollen, nectar, and honey. The first contains the nitrogen of their diet, and the other two the hydrogen, carbon, and oxygen. Observations made by the writer indicate that the pollen is not digested until it gets into the intestine, for masses of fresh-looking grains nearly always appear in the rear part of the ventriculus, which is otherwise filled with a brownish slime. On the other hand, the nectar and honey are very probably digested in the ventriculus, and in large part absorbed from it.

The *salivary glands*, located in the back part of the head (Fig. 6, *2Gl)* and in the front part of the thorax *(3Gl)* open upon the upper part of the labium (Fig. 3, F, *SalDo)*. The saliva can thus affect the liquid food before the latter enters the mouth, or it can be allowed to run down the proboscis upon hard sugar in order to dissolve it, for the latter is eaten with the proboscis, not with the mandibles.

The large glands (Fig. 6, *1Gl)* situated in the front part of the head are supposed, by some students of the bee, to form the white pasty brood-food and the royal jelly. Others think that these substances come from the stomach. More investigation of the subject must be made, however, before the question can be decided; but the contents of the stomachs of the workers have no resemblance to the brood-food.

The circulatory system is very simple, consisting of a delicate, tubular, pulsating *heart (Fig. 1, Ht)*, in the upper part of the abdomen, of a single long blood vessel, the aorta *(Ao)*, extending forward from the heart through the thorax into the head, and of two pulsating membranes, the *diaphragms (DDph* and *VDph)*, stretching across the dorsal and ventral walls of the abdomen, but leaving wide openings along their sides between the points of attachment. The heart consists of four consecutive chambers, *1ht-4ht*, which are merely swellings of the tube, each having a vertical slit or *ostium (Ost)* opening into each side.



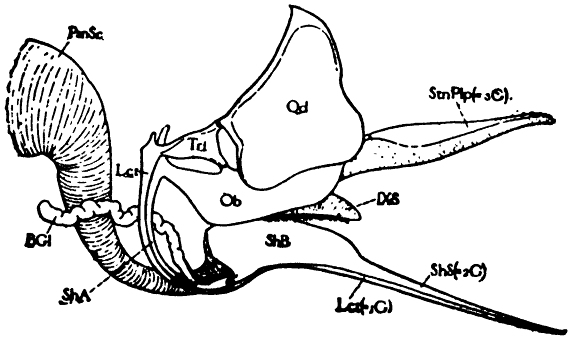
From Bulletin No. 18, "The Anatomy of the Honeybee," by Snodgrass, Department of Agriculture, Washington, D. C.

Fig. 4.—Details of legs. A, front leg of worker, showing position of antenna-cleaner (dd and ee); B, end of tibia of front leg showing spine (ee) of antenna-cleaner; C, antenna-cleaner, more enlarged; D, middle leg of worker; E, hind leg of queen; F, hind leg of worker, showing pollen-basket (Cb) on outer surface of tibia; G, inner view of basal joint of hind tarsus of worker, showing the brush of pollen-gathering hairs; H, hind legs of drone; Cb, corbiculum, or pollen-basket; Cla, claws; Cx, coxa; dd, notch of antenna-cleaner on basal joint of first tarsus; ee, spine of antenna-cleaner on distal end of tibia; Emp, empodium, sticky pad between the claws for walking on smooth surfaces; F, femur; ff, "wax shears"; Tar, tarsus; 1Tar, first joint of tarsus; Tb, tibia.

The *blood* is the colorless liquid that fills the spaces about the viscera of the body cavity. The dorsal diaphragm and the heart pulsate forward. The blood in the cavity above the former enters the ostia of the heart, and is pumped forward through the aorta and out into the cavity of the head. From here it percolates back through the thorax and enters the space beneath the ventral diaphram *(VDph)* of the abdomen. This membrane pulsates backward, and the blood is driven posteriorly and upward, through the lateral openings, around the abdominal viscera, and again into the dorsal or pericardial cavity of the abdomen, where it begins its circulation anew. In insects the principal function of the blood is to distribute the food which dissolves into it from the alimentary canal.

The *respiratory system* is very highly developed in the bee, consisting (Fig. 1) of large air-sacs *(TraSc, 1-10)* in the head, thorax, and abdomen, and of tubes called tracheae given off from them, *(Tra, LTra)*. Fig. 1 shows principally the parts in only the right side of the body. In the abdomen a large sac *(10)* lies on each side connected with the exterior by short tubes opening on the sides of the first seven segments. Three other pairs of such openings occur in the thorax; but the last of these, being in the propodeum, really belongs to the abdomen. Thus there are in all ten pairs of breathing apertures, and they are called the *spiracles*. None occur on the head. The tracheal tubes given off from the air-sacs branch minutely to all parts of the body and penetrate into most of the tissues. Hence oxygen is carried directly to the cells that use it, and the blood of insects is thus relieved of the work of distributing it—one of its principal functions in vertebrate animals. The respiratory movements are produced by muscles of the abdomen.

The life processes of the cells of the body result in the formation of products excreted by the cells into the surrounding blood. These products are poisonous to the system unless immediately changed into simpler substances. This change is effected partly by the inhaled oxygen combining with the waste products, resulting in the formation of compounds of nitrogen which dissolve in the blood, and of carbonic acid gas which diffuses into the tracheal tubes and is exhaled. The nitrogen compounds are supposed to be removed by the *Malpighian* tubules (Fig. 6, *Mal*), which are regarded as the kidneys of insects.



From Bulletin No. 18, "The Anatomy of the Honeybee," by Snodgrass, Department of Agriculture, Washington, D. C.

Fig. 5.—Left side of sting and its accessory plates, with alkaline gland (BGl) and base of poison-sac (PsnSc) attached. BGl, alkaline-poison gland; Lct, lancet; Ob, oblong plate; PsnSc, base of poison-sac holding secretion from acid-gland (see Fig. 8); Qd, quadrate plate; IXS, median part of ninth abdominal sternum; ShA, arm of sheath; ShB, bulb of sheath; ShS, shaft of sheath; StnPlp, palpus of sting; Tri, triangular plate.

The *nervous system* consists of a series of small masses of nerve tissue called *ganglia*, lying along the median ventral line of the body cavity (Fig. 1, *1Gng-7Gng)*, the two of the thorax being much larger than those of the abdomen. Each two are connected by a pair of cords called *commissures*. Nerves are given off from these ganglia to the various organs and parts of the body, and to the legs and wings. In the head there are two ganglionic masses. One is called the *brain (OpL)*, and is situated above the oesophagus, where it gives off nerves to the eyes, the antennae, the front, and the labrium. The other, called the *suboesophageal ganglion*, lies in the

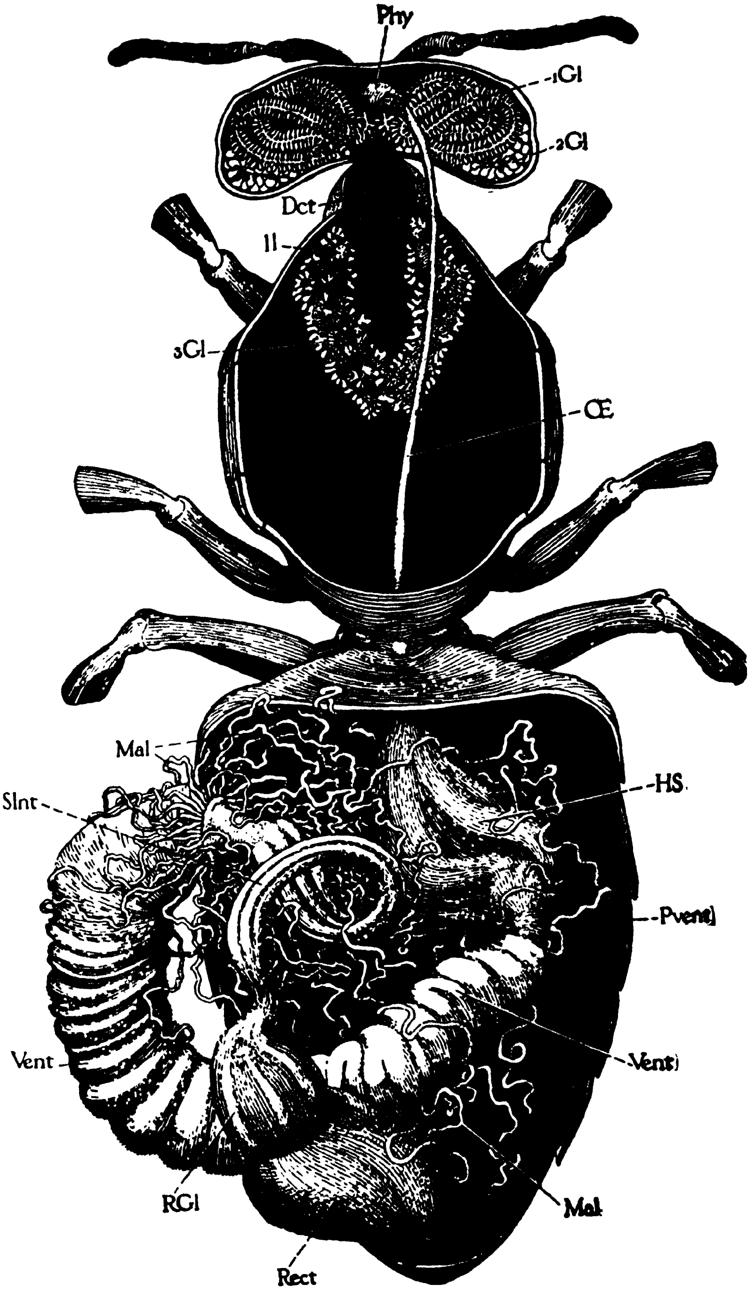


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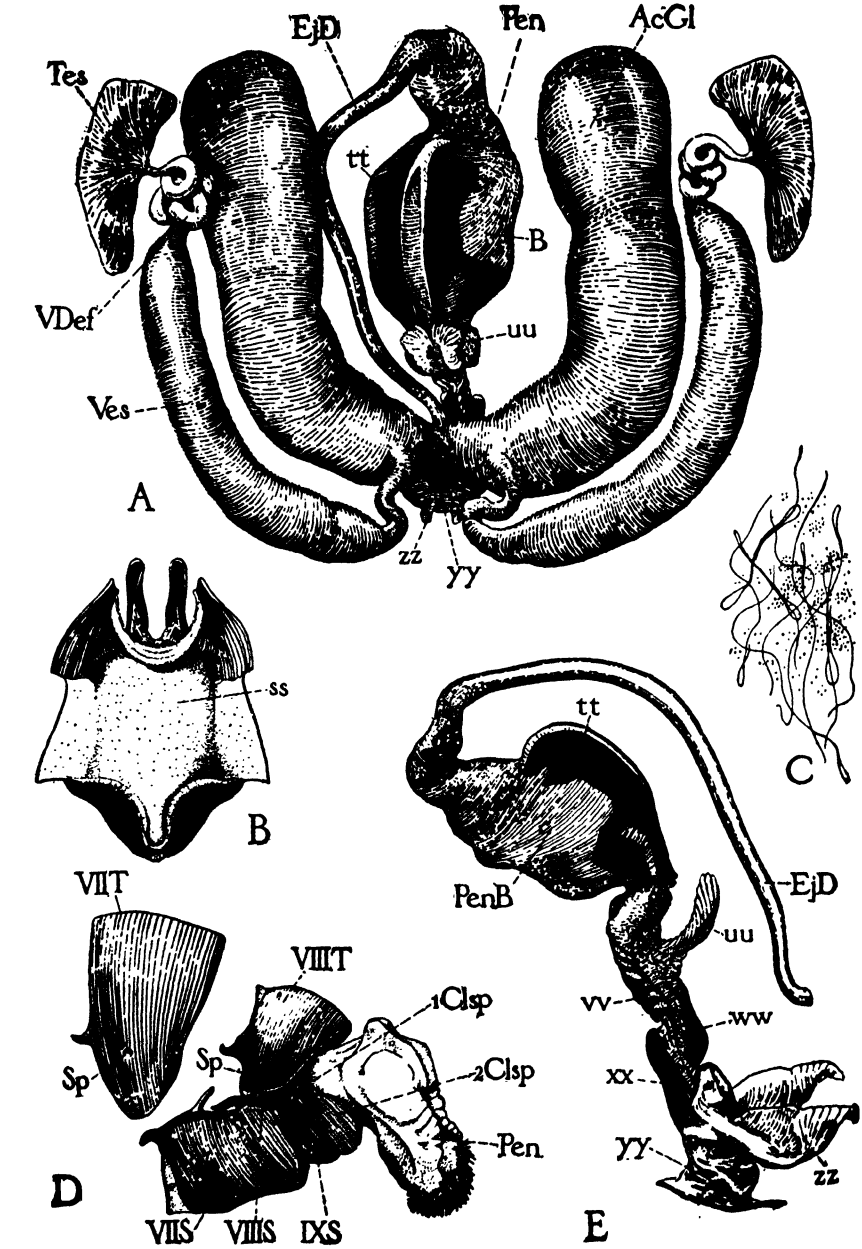
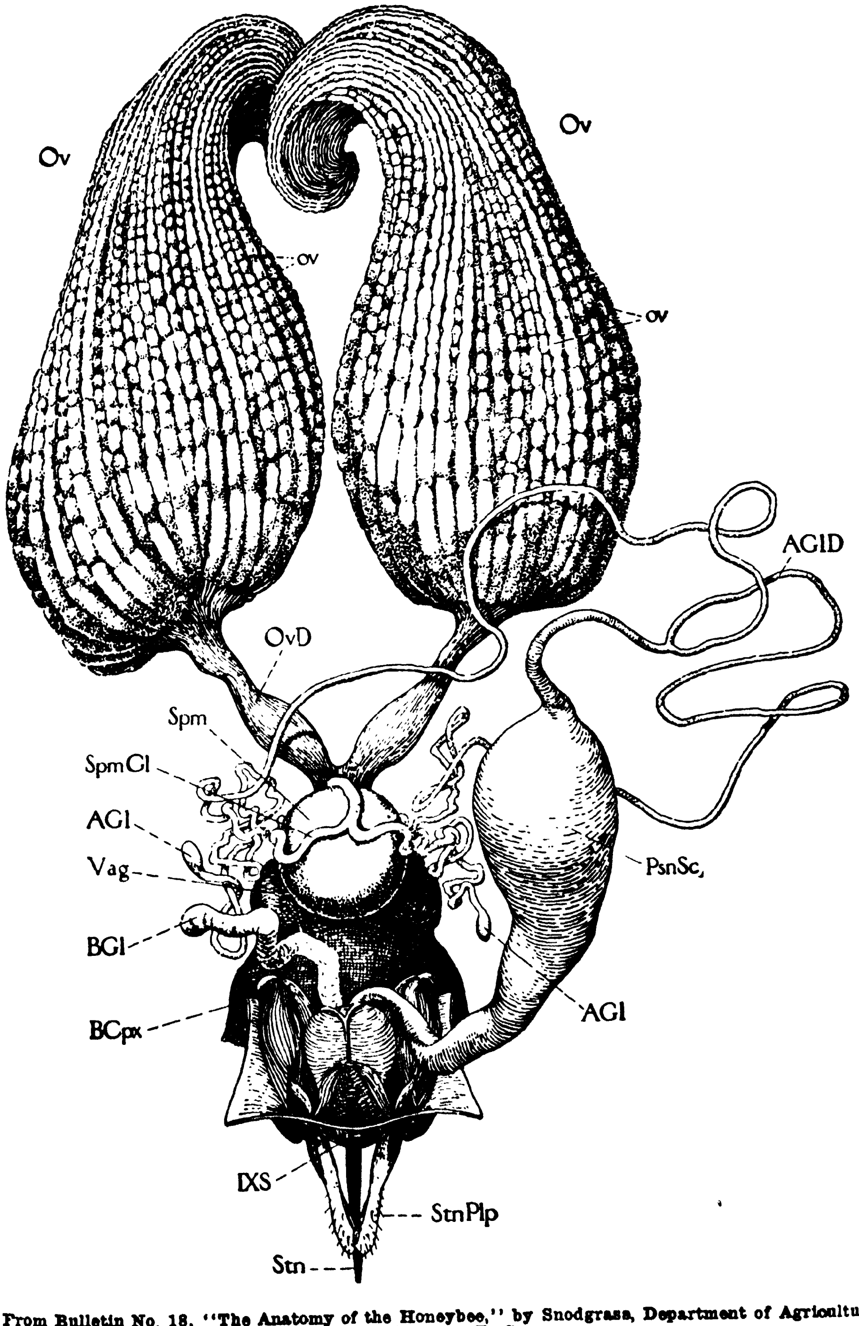
Fig. 6.—Alimentary canal and salivary glands of worker, dorsal. Dct, salivary duct; 1Gl, pharyngeal glands of head (supracerebral glands); 2Gl, salivary glands of head (postcerebral glands); 3Gl, salivary glands of the thorax; HS, honey-stomach; ll, reservoir of thoracic salivary gland; Mal, Malpighian tubules; OE, oesophagus; Phy, pharynx; Pvent, proventriculus; Rect, rectum; Rgl, rectal glands; SInt, small intestine; Vent, ventriculus.



From Bulletin No. 18, "The Anatomy of the Honeybee," by Snodgrass, Department of Agriculture, Washington, D. C.

Fig. 7.—A, reproductive organs of drone, dorsal; B, inner view of dorsal wall of penis; C, group of spermatozoa; D, terminal segments of drone, lateral, showing penis (Pen) partly protruded; E, lateral view of penis and ejaculatory duct (EjD); AcGl, accessory mucous gland; B, bulb of penis; 1Clsp, 2Clsp, clasping organs of ninth abdominal sternum; Pen, penis; PenB, bulb of penis; VIIS-IXS, seventh to ninth abdominal sterna; ss, gelatinous mass of inner wall of bulb of penis; VIIT-VIIIT, seventh and eighth abdominal terga; tt, dorsal plates of bulb of penis; Tes, testis; uu, fimbriated lobe at base of bulb of penis; vv, ladder-like plates of penis; VDef, vas deferens; Ves, seminal vesicle; ww, dorsal and ventral plates in wall of penis; yy, terminal chamber of penis through which the rest is everted; zz, copulatory pouches of penis.



From Bulletin No. 18, "The Anatomy of the Honeybee," by Snodgrass, Department of Agriculture, Washington, D. C.

Fig. 8.—Reproductive organs of queen, dorsal, together with sting, its muscles, glands, and poison-sac. AGl, acid-glands of sting; AGlD, duct of acid-glands; BCpx, bursa copulatrix; BGl, alkaline gland of sting; Ov, ovaries; ov, ovarioles; OvD, oviduct; PsnSc, poison-sac; IXS, median part of ninth abdominal sternum; Spm, sac of spermatheca; SpmGl, spermathecal gland; Stn, sting; StnPlp, palpus of sting; Vag, vagina.

lower part of the head, and innervates the mouth parts, while it is connected by commissures with both brain and the first thoracic ganglion.

The *reproductive system* consists of those organs that produce the spermatozoa in the male and the eggs in the female and their accessory parts.

The spermatozoa are formed in the *testes* of the male (Fig. 7, A, *Tes)*, a pair of small bodies in the front part of the abdomen, said to be developed at their highest in the pupal stage. Each is connected by a coiled tube, the *vas deferens (VDef)*, with a long sac, the *seminal vesicle (Ves)* in which the spermatozoa are stored during the adult stage of the drone's life. The two vesicles open into the bases of two enormous *mucous glands (AcGl)* which come together in a narrow muscular tube, the *ejaculatory duct (EjD)*. This opens into the anterior end of the penis *(Pen)*. This is a complicated organ, shown at E, Fig. 7. It is ordinarily contained within the cavity of the abdomen; but during copulation it is entirely everted, and its basal pouches *(zz)*. lock into corresponding pouches of the oviduct of the queen.

The eggs are formed by the *ovaries* of the female (Fig. 8, *Ov)*, each of which consists of a thick mass of tubules called the *ovarioles (ov)*, within which the eggs grow from simple cells at their upper ends into the mature eggs found at their lower ends. The ovarioles of each ovary open into an *oviduct (OvD)*, which two unite into a wide median tube called the *vagina (Vag)* that swells posteriorly into a large pouch known as the *bursa copulatrix (BCpx)*, opening to the exterior in the eighth segment beneath the base of the sting.

During copulation the drone ejects the spermatozoa into the upper end of the vagina of the queen. The spermatozoa consists of minute vibratory threads Fig. 7, C), which, probably, by their own motion, make their way up through a small tube opening into the dorsal wall of the vagina, and so reach a globular sac (Fig. 8, *Spm)* called the spermatheca. Here they are held during the rest of the lifetime of the queen, to be extruded in small bundles, of about a hundred each, according to Breslaw, upon the eggs passing out of the vagina. Thus are the female eggs *fertilized*, the drone eggs developed without the addition of the male element.

ANGER OF BEES.—The term "anger" hardly applies to bees, notwithstanding there is a general impression that they are always in a towering rage, ready to inflict severe pain on everything and everybody coming near them. Bees are, on the contrary, the pleasantest, most sociable, genial, and good-natured little beings that are met in all animated creation, when they are understood. Their beautiful comb can, when one knows how, be torn to bits right before their very eyes without their showing a particle of resentment; and with all the patience in the world they will at once set to work to repair it—and that, too, without remonstrance. If they are pinched they will sting; and a human being who has energy enough to take care of himself would do as much had he the weapon.

To open hives in such a way as to avoid stings, see Manipulation of Colonies, and Stings.

In order that the reader may better understand that which follows, it may be well to set forth two or three fundamental conditions under which bees become cross or nervous and unpleasant to handle. First, a slackening or a shutting-off of the food supply obtained either from the fields in a natural way, or from exposed sweets, always has a tendency to make bees ill-natured. If the honey flow is unusually strong, and then slackens up very rapidly, the bees in the whole yard become cross. This is particularly noticeable at the closing of basswood or after the drying-up of certain honeydews deposited on the leaves of trees, or during a flow from buckwheat. This plant yields heavily in the morning, and then slackens up suddenly during the middle of the day. It is then that bees are cross. If the bees are robbing and combs or syrup are carelessly exposed, and if these combs or syrup are suddenly put under cover, so that not another drop can be secured, the bees will usually sting furiously, when, if their supply were allowed to stand and gradually diminish, they would be much better natured.

If some one carelessly exposes sweets in quantities during a dearth of honey when bees are disposed to rob, this will have a tendency to stir up the whole apiary. The roar of the excitement may be heard some distance from the yard. Thousands and thousands of bees will be found flying around everywhere to dis-

cover where this new supply is located; but, as a general thing, bees are not cross when trying to find the source of the sweet. The real trouble begins about the time the supply gives out.

During the middle hours of the day, when the air is warm and balmy and the bees are going into the fields, they are generally very gentle. But if a sudden rainstorm comes up, shutting off the supply of nectar, they will usually be quite cross, and this bad temper will last until the normal supply begins to come in again.

Bees are apt to be cross toward night on cool or chilly days. When all are at home, and the hives are opened unceremoniously, they may resent the intrusion. It is then that beginners discover, much to their sorrow, that bees should not be handled during cool or chilly weather, right after a rain, or at night.

Strong colonies are far more difficult to handle than weak ones.

By keeping these facts carefully in mind, when the following incidents are related, one will more readily discover why bees are cross.

A few years ago a very intelligent man procured some Italians, an extractor, etc., and commenced bee culture. He soon learned to handle them, and succeeded finely; when it came time to extract, the whole business went on so easily that he was surprised at what had been said about experienced hands being needed to do the work. He had been in the habit of doing his work as directed, toward the middle of the day, while the great mass of bees were in the fields; but in the midst of a heavy yield of clover honey, when the hives were full to overflowing, they were one day stopped by a heavy thundershower. This, of course, drove the bees home, and at the same time washed the honey out of the blossoms so completely that they had nothing to do but remain in the hives until more was secreted. Not so with their energetic and enthusiastic owner. As soon as the rain had ceased, the hives were again opened, and an attempt made to take out the frames, as but a few hours before; but the bees, which were all gentleness then, seemed now possessed of the very spirit of mischief; and when the operator had been severely stung, he concluded that prudence was the better part of valor and stopped operations for the day. While loads of honey were coming in all the while, and every bee rejoicing, none was disposed to be cross; but after the shower, the bees were standing around idle; and when a hive was opened, each was ready to take a grab from its neighbor, and the result was a free fight in a very short time.

There is nothing in the world that will induce bees to sting with such wicked recklessness as to have them get to robbing combs or honey left exposed when they have nothing to do. When the supply is exhausted their frenzy reaches its height. From a little carelessness in this respect, and nothing else, whole apiaries have been so demoralized that people were stung when passing along the street several rods distant. During the middle of the day, when bees were busily engaged on the flowers during a good yield, we have frequently left filled combs standing on the top of a hive from noon until evening without a bee touching them; but to do this after a hard rain, or at a time when little or no honey is to be gathered in the fields, might result in the ruin of several colonies, and the bees being voted a nuisance by the whole neighborhood.

Almost every season some letters are received complaining that bees have suddenly become so cross as to be almost unmanageable, and those letters come along in July, after the clover and linden have begun to slacken. As already pointed out at the beginning of this article, it is the slackening or stoppage of the flow that makes the bees irritable.

Bees are not so very unlike mankind after all, and all one has to do is to avoid opening a hive for a few days, until the bees get used to the sudden disappointments of having avenues through which they were getting wealth so rapidly, cut off. After a week or ten days they will be almost as gentle as in times when they gathered half a gallon of honey daily, if care is taken not to let hives be open too long nor to leave any bits of honey or comb about.

How the Presence or Absence of Shrubbery or Trees Affects the Temper of the Bees in the Yard

It has been shown time and time again that the same bees that are docile as kittens in the home yard, with plenty of shrubbery to shut off the view of individual colonies, will often be as cross as hornets when placed in an out-apiary on

a level piece of ground where their hive is in view of every other hive, without any obstructing shrubbery or trees. The reason for it is plain. If there are any cross bees in the air, and they see a moving object like a beekeeper, for example, going through the yard, they will immediately come buzzing about him with the peculiar angry scream that a mad bee always has. Those same bees, when located in a yard where there is plenty of shrubbery, and where they can not see moving objects as readily, will forget all about the source of their irritability, and either go to the fields or into their own hives.

Several times we have been tempted to kill all the queens in a certain yard because their bees were so very cross, only to discover later on that, when we moved them to the home yard, where there were grapevines shutting off the view of their hives, there was nothing the matter with the bees, but only with their previous environment. For that reason alone some of the crossest bees we have ever known have become very tractable when placed in a small orchard or piece of woods. The crossest bees will also become very docile when put into a house-apiary. When the owner is inside he can not be seen, of course, and he can work inside of the building without hindrance.

Colonies that are located in dense shade throughout the day are usually ill-natured, while those out in the sun are good-natured.

To make bees good-natured by feeding, see Feeding Outdoors; also see Robbing, Stings and Manipulation of Colonies.

A full explanation of why bees are cross is given from a different angle in Bee Behavior further on, subhead Why Bees Sting.

ANTS, as well as bees, represent one of the most important groups of social insects that we find. Both work together in communities representing a considerable population like that of a city or town in the human family. Ordinarily there is no antagonism or rivalry between ants and bees. In some of the northern states of this country ants build troublesome nests near beehives. They sometimes build nests inside of a hive, more for warmth than because they wish to prey upon the bees or take the honey.

In the southern states, and in California, ants are sometimes very troublesome and destructive, especially the Argentine ant that eats out the wood of a bottom-board, and some of the larger species that make their nests in trees and in the ground. Some of these giant ants will begin an actual warfare upon a colony of bees when they are strong enough.

Mr. O. O. Poppleton, at one time one of the most extensive beekeepers of Flor-

The Calkins ant-proof hive-stand. It differs from other hive-stands in that near each of its four corners it has twenty-penny spikes driven in about half their length and gauged to fit snugly to the inside rim of the reversible bottom-board on each side. Around the projecting portion of the spikes is wound felting which is afterward soaked in axle grease. On top of these four nails is carefully adjusted a colony of bees. For obvious reasons the alighting-board connects with the hive-stand and not with bottom-board of hive.

ida, said that ants, with one exception, are the worst enemies bees have in that state, and that, unless the beekeepers were alert, full colonies of bees would be destroyed. The largest species are strictly nocturnal in their habits, seldom being seen in the daytime except when disturbed. At sundown they will begin their nightly quest for food and very often will attack a colony of bees. During the daytime perhaps only one or two of them will be seen at a time and attract no attention. But if a dozen or more are found during the middle hours of the day it may be suspected that a nest of these ants will suddenly make a raid some night. At first they will begin nightly attacks continuing to worry the bees until they are strong enough to overcome the entire colony. Their mode of attack is by biting off the wings and legs and otherwise crippling the bees. The bees

fight back courageously for a day or two, according to the relative strength of the two belligerents. The inside and outside of the hive will be strewn with dead ants and dead bees, but in the end the bees themselves are overpowered and destroyed.

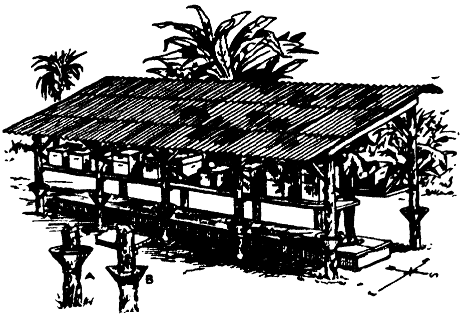
The beekeeper can usually prevent any such onslaughts by watching a trail of ants going toward any particular colony. By trailing back he can find the nest and destroy it. Mr. Poppleton found it necessary at times to use a lantern to go through his apiary at night. An electric flashlight would be better. When he sees the ants around the entrances or hears the bees commence to whine, he then traces back to where the nest is and destroys it.

Take a crowbar and jam it down into the center of the nest. Pour in a gill of carbon bisulphide, then close the opening made by the crowbar with a plug of sod. The fumes of the gas will penetrate all the galleries in the nest, destroying adults as well as the young of the ants. Calcium cyanide can be used. This can be applied safely by following the directions for using Cyanogas, a commercial product in the form of a powder. Both carbon bisulphide and the Cyanogas can be obtained in quart tin cans at most drug stores.

The hives themselves in tropical climates can be protected by placing them upon stands, the legs of which stand in pans of kerosene or oil; or, a hive-stand can be made with four large spikes driven at the four corners. A twenty-penny spike is about right. They are left sticking out of the wood about two inches. Around each spike is wound felt, which is afterwards soaked in axle-grease. On top of the four nails is then placed a hive of bees. The ants will not cross the axle-grease, and the colony will be protected.

To circumvent them it is necessary to destroy all their nests within a radius of 100 yards of the apiary by the application of bisulphide of carbon to their nests. But this precaution alone will not suffice, and it will be necessary to adopt further measures. Luckily it is not difficult to do this, as tropical beekeepers are obliged to keep their hives under a shed, for excellent reasons.

In erecting a shed, we can take measures to prevent ants from gaining access to the hives. Add cups to all the posts used to support the structure. The illustration below shows very clearly how this is accomplished with but little expense or trouble. The cups are filled



Ant-proof beehive shed.

with coal tar, creosote, or crude petroleum, all of which the ants positively dislike for two reasons—they stick to their feet and the smell is repulsive. No ant will attempt to cross such a mess as this, hence the bees are secure. The warm climate keeps the tar, etc., always soft; and if some rain falls into the cups it does no harm, as the water also tastes of the tar.

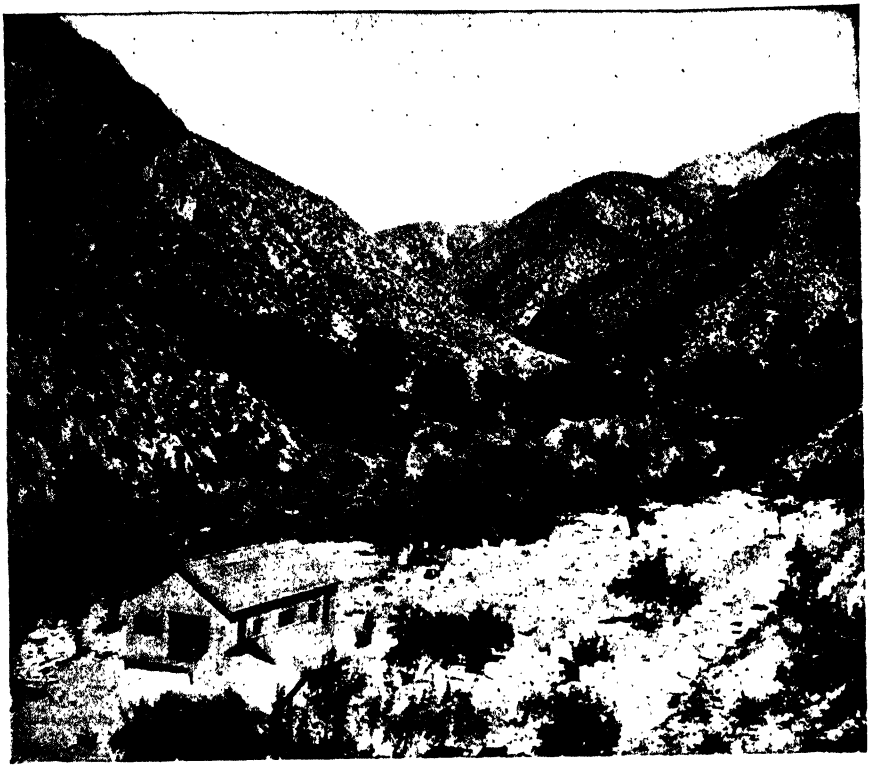
In working with the bees care should be taken to see that nothing is left which will form a "bridge" whereby the ants may reach the beehives while the apiarist is absent. One of the worst things that can happen is to allow the ants to get a taste of the bees; for once they do they are sure to linger around waiting for an opportunity to get into the hives.

APIARIST.—An apiarist is one who manages one or more yards of bees for pleasure or profit.

APIARY.—A place where a number of colonies of bees are kept is called an apiary or bee-yard.

Location

Beekeeping is practiced even in the heart of some of our large cities. In the suburban districts bees can be kept on a small plot of ground in the back yard. In the heart of business sections bees are very often kept on the roofs of buildings, sometimes on the very tops of skyscrapers. In such cases, on account of the intense sunlight and lack of natural shade in the form of bushes, shade-boards should be provided as described further on in this article. Such an apiary should



APIARY OF THE LATE M. H. MENDLESON.

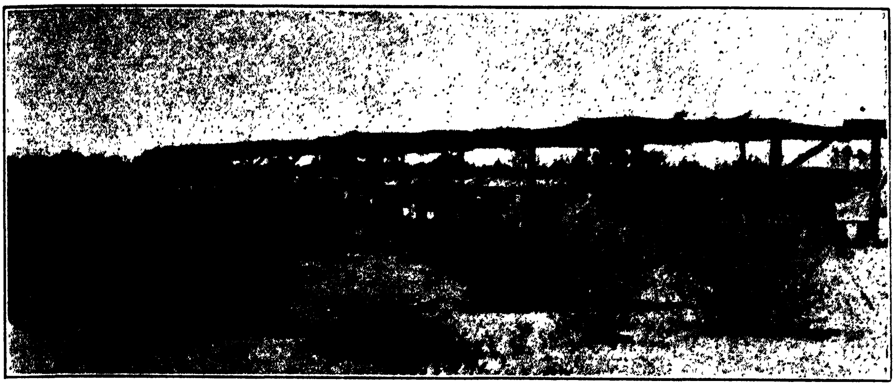
This apiary occupies a very unique position down in the bottom of the canyon, where it is well protected. The ground has been leveled off and terraced, and the rows of hives are straight and parallel. This is one of the most picturesque spots for an apiary in the world. From it some of the best sage honey of California is obtained, and no wonder: for the mountain sage is always in sight and in reach of the bees. The patches of white, black, and button sage on the mountain side can be plainly seen.

When the author visited this yard in 1901, he considered it one of the best-located yards in all California—well protected and the bee pasturage at close range. But for the fact that there is only about one good yield of honey in five years, this would be a veritable bee paradise indeed.

be established like those on the ground in all essential points.

It is not always possible to select the most desirable location for an apiary, and it is therefore necessary to take what can be secured; but where conditions permit it is advisable to select the rear of a village lot, or, if located on a farm, a place back of the house in an orchard. Avoid locating the bees next to a line fence on the other side of which is a cultivated field, as a team of horses while working the soil may be stung by bees flying to the fields.

It is desirable, of course, though often not possible, to have a level plot of ground with moderate shade and suitable windbreaks. A smooth plot of ground renders the use of a wheelbarrow or hand-car for handling loads much more pleasant and convenient. An ideal spot would be an orchard of young trees 75 or 100 feet from the road or highway. Usually the rear end of a village lot, just back of the house, will answer very nicely. If the apiary must be located close to the highway, then a high board fence should be placed between the bees and the street. A hedge of althea, osage orange, or evergreens; a trellis of some sort of vine; trees, shrubbery, or anything that will cause the bees to raise their flight to a height of 10 to 12 feet above the traffic of the street should be used. In any case, the bees should never be allowed to go directly from their hives on a line that would encounter vehicles or pedestrians; otherwise their owner may have complaints or



A typical Imperial Valley apiary with grass covered sheds for shade. The sagebrush of the desert is shown in the foreground.

a possible suit for damages. (See Bees as a Nuisance.)

The Importance of Shrubbery or Small Trees in the Bee-Yard

Under the head of Anger of bees, near the close of the article, attention is called to the value of small shrubbery or trees to shut off the views of individual colonies from each other. The matter is so important that it is mentioned again in order that the reader may wisely locate his bees.

The same bees that are gentle at the home yard, where they are well screened or located, sometimes become very cross when placed out in the open field without shrubbery or trees. A little shade on hot days is of great value in protecting the hive from the direct rays of the sun. Aside from the value of the shade, if the shrubbery is tall enough it adds a great deal to the comfort of the apiarist himself. In an open yard it usually becomes necessary to wear a veil to prevent the bees from stinging the face without warning. In a yard that has shrubbery, one can often work all day without a veil, and sometimes with but very little smoke. It is not always possible to locate a yard in the midst of shrubbery or small trees, and one has, therefore, to

A close up view of an Imperial Valley bee shed. The owner, Mr. Hildebrandt, believes in the food-chamber as an insurance for a honey crop.

APIARY OF HARRY DUBOIS ON THE LOXAHATCHIE RIVER, FLORIDA

The idea of a screen of slats overhead is not to shut off the sun's rays entirely, but to break them up. Too much shade does as much harm as too little in this country. The same general scheme of semi-shading could be carried out to advantage in many localities. It would not answer in Arizona, New Mexico, and the Imperial Valley, California, because the sun is too hot and the climate too dry.

take what he can find, which very often is an open space in one corner of a lot.

Shrubbery consisting of small bushes or trees has an additional value in that it enables the bees to locate their entrances a little more easily. When the hives are placed together without any space between there is more or less drifting—that is to say, the bees make mistakes and go into the wrong hives. (See Drifting.) The unfortunate part of it is that the strong colonies will draw from the weaker, because the young bees, in their initial flight, are quite inclined to join the hive where the most bees are flying. At the author's home yard, colonies are placed on the north side of the individual grapevine trellises. These trellises are between six and seven feet high. The vines are all very carefully trimmed, and the fruit pays for the labor of keeping them in order. Strangers at any time are permitted to go through this yard, and it is very seldom that any one is stung, because an occasional cross bee or dozens of them, on account of the obstructions to the general view by the vines, are unable to see any moving object, and therefore they do not follow one about nor offer to attack.

Too Much Shade Detrimental

If the orchard where the bees are to be located is made up of *old* trees there may be from four to five hives grouped under each tree. If, on the other hand, it consists of young ones, not more than one or two hives should be placed at a tree, and always on the north side, so as to be in the shade. When possible, the hives should be so located that they will get the morning sun up to eight or nine o'clock, and the afternoon sun from three or four o'clock on. Too much shade is detrimental, and too much hot sun pouring directly on the hives is equally so. Experience has shown that a very dense shade over bees in the morning hours retards the building up of the bees in the spring. Colonies located on the *west* side of a building or barn, or under densely foliaged trees, so that they do not get the morning sun, will

not, as a rule, be as far along by the time the honey flow comes on as those that have the morning sun or only moderate shade. An *afternoon* shade does not do as much harm as one in the forenoon.

If there are no trees of any sort in the yard, what shall be done? One of four courses lies open: First, to use double-walled hives; second, single-walled hives with shade-boards; third, single-walled hives having on the south side of them some sort of vine that can be reared up within a year or two. A grapevine trellis 8 feet high and 10 or 12 feet long, running from east to west, well covered with a vine, can be made to protect from five to ten hives. On this trellis, grapevines or any other quick-growing vine may be reared to provide shade during the heat of the day. The fourth and last plan is to use an overhead trellis, making use of straw, dried grass, or brush for covering, such as are used in Arizona and Cuba. These trellises are about seven feet high, and run from east to west, so that the sun, nearly overhead as it is in Arizona

Robertson method of shading the hives and the entrances in the morning.

and southern California, never strikes the hives from morning till night. These trellised shades, if there are no trees, are indispensable in hot, dry climates. They thoroughly protect the bees, prevent combs from melting down. (See pages 39 and 40, cuts above.)

Some beekeepers prefer to use shade-boards. These may be made in the form of large panels cleated at the ends, and composed of two or three boards of the cheapest lumber that can be had, or they may be made of common shingles in the manner shown in the illustrations. In some cases it may be advisable to lean the panels against the hives rather than to place them on top. When used on top they should be large enough to extend a foot over the front and rear, and an equal distance on the south side where the hive faces east or west. They are then held se-

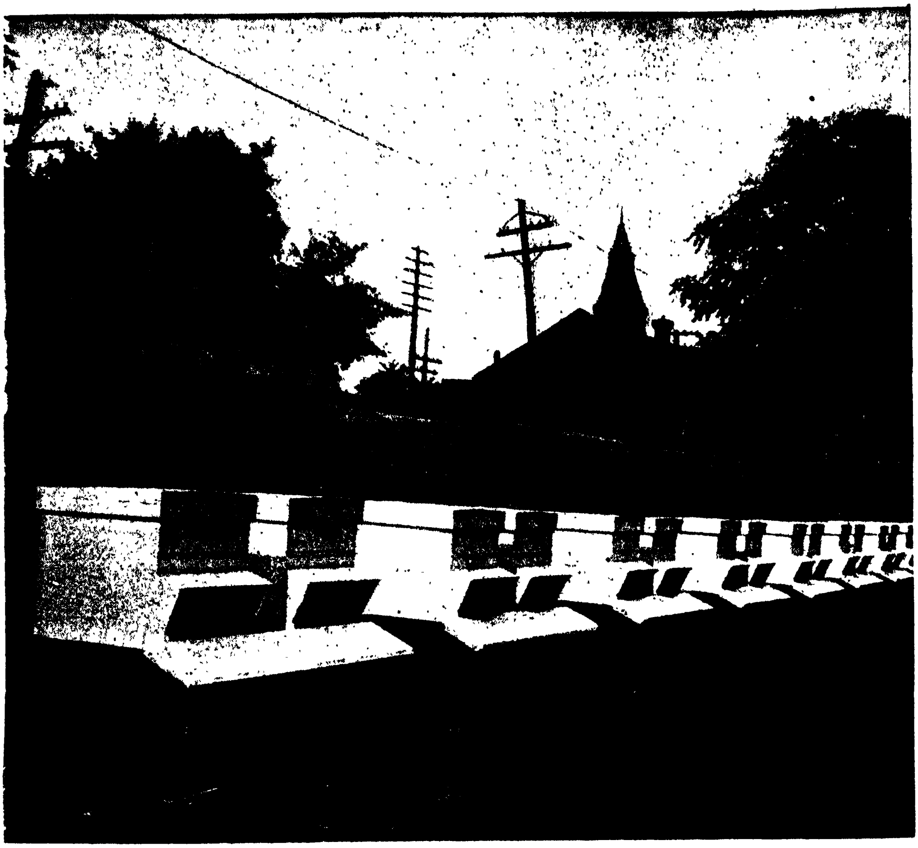
Shading tops and fronts of hives during the hottest part of the day.

curely in place by a stone weighing 15 or 20 pounds. But whenever one manipulates these hives he is required to lift a heavy stone and remove an awkward shade-board before he can do any work with the bees.

When hives are placed in long rows close together, as under a shed or on the roof of a building, it is very important that they differ from each other in appearance so that the bees may distinguish their own hive from all the rest. The differentiation may be accomplished in various ways: first, by painting the hives different colors; second, by using a different entrance or alighting-board; third, by placing a stone or other distinguishing object near the entrance. The idea is to place some distinctive mark by which each hive may be quickly recognized by its tenants. The best way to make such mark is at the entrance so that all the bees can see it, both on leaving and returning. (See Arrangement of Hives, under head of Apiary.)

Windbreaks

The most perfect windbreak is an inclosure of woods on three sides, with an opening to the south. This, however, is not available often. An apiary so situated that there is a clump of woods on one



APIARY OF CHAS. Y. HAKE, YORK, PA.

This is a back-lot apiary that is well screened from prevailing winds, as most yards of this kind are. It therefore follows that such yards winter better than the large apiaries out in the open. Mr. Hake has his colonies elevated on hive-stands for convenience in handling. The objection is that during bad, chilly weather some bees drop short of the entrance. If the hives were on or near the ground, the bees could crawl in and be saved. One trouble with this arrangement, the hives are all too much alike. See page 48.

side and buildings on two other sides, leaving only a southern exposure, is well sheltered from the prevailing winds. It is important to remember that if there are woods or buildings around the east side of the bee-yard, enough to shade the hives until about noon, the bees will not build up as fast in the spring as those that can get the morning sun up to 10 or 11 o'clock. In the absence of any natural or accidental protection whatever, it is highly important that some sort of windbreak be provided. If it is desirable to put up something permanent and something that will not rot out or require repairs, the apiary should be outskirted with rows of hardy-growing evergreens. These, for the first few years, would afford but a scanty protection; but in 10 years' time they answer their purpose admirably. In 1879 A. I. Root enclosed his apiary with evergreens. They have proved to be very hardy and thrifty.

A good windbreak is now regarded, for winter protection, as about as important (and some think more important) for outdoor-wintered bees as packing and double-walled hives. Of course, it is better still to have hives packed as well as protected from the prevailing winds. Experience has shown that colonies, even though well packed, but placed where there are sharp wind exposures on an elevation, will often die before spring, or become so weakened as to be practically worthless, while colonies of the same strength in single-walled

An apiary in the white clover and alsike region in Michigan that has a background of woods against the prevailing winds. The hives are placed in irregular groups. See page 48.

hives screened against the wind will winter comparatively well.

In a location on a prairie, especially if it is permanent throughout the year, care should be taken to see that the apiary is protected on the north and west. Sometimes an apiary can be placed at the bottom of a hill lying at the north; but it would be far better if shrubbery were placed at the brow of the hill to prevent the wind from diving down and striking the colonies with full force.

The best windbreak consists of trees or shrubbery of some sort. A solid fence is not so effective, because the wind will strike it squarely and glance upward, when the on-rushing blast will cause it to roll and dive downward.

At one of the authors' outyards there was a high board fence on the north, and it was distinctly noticeable that the third row from the fence would come out in the spring in much weaker condition than the rows either to the north or south. Many

Colonies in protected place with good air drainage and background that shut off the prevailing winds. In this case the hives are too much alike, causing drifting. See pages 40, 41, and 48.

Another Root Company apiary in sweet clover territory. Note that the hives are placed among the shrubs and small trees in such a way that they are protected from cold winds in the fall, spring and winter. See page 40.

colonies in the third row died outright. This happened several winters. Finally an investigation showed that, during a blow with fine particles of snow, the wind would strike the fence, glance upward, and this upward blast striking the wind from the north would roll like a sort of horizontal whirlwind. This would gradually sag until its full force struck the entrances of the hives in the third row, which faced south. This horizontal whirlwind seemed to spend all its fury on this row of hives, while the other rows were left comparatively free. Had it not been for the fine snow it would not have been possible to follow the course of wind.

One of Ray C. Hiltner's apiaries located in the woods near Continental, Ohio. Note that in this and in the cut above the hives are placed irregularly for the reasons explained on pages 40, 41, and 48.

Authors' apiary in sweet-clover locality almost surrounded by woods. Hives face east and south.

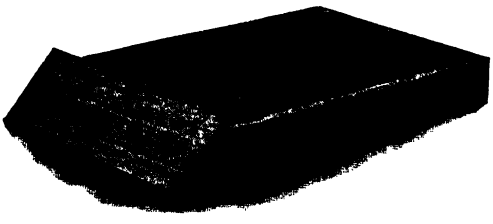
A common fence made of rails, pickets, or boards, will help break the force of the wind; but in these latter days barbed wire is used almost exclusively. It is best to locate the hives either in the center of the orchard, or, if the orchard is small, in an enclosure of low shrubbery or bushes under trees. Berry vines, grapevines, or trimmings from the trees in the form of brush, sometimes answer as a very good substitute.

Where the bees are located out on a prairie in the north with a wind-sweep for miles, it is quite essential that there be a barrier of some sort. Quick-growing shrubbery should be placed around the yard. In the meantime a screen of brush may be used. If a fence is erected, one made of pickets, so that the wind can filter through and not glance upward and downward, as explained, it will be better. A vertical trellis may be made for quick-growing vines; but the vines should be of such a nature that the intertwining branches will make a filtering screen even when the leaves are off. Evergreens make the best windbreaks of all, but it takes years to get them. (See Windbreaks, under head of Wintering Outdoors.)

Hive-Stands

While a hive can be set directly on the ground, yet on account of the danger of dampness and the rotting of the bottom-board, it is advisable to set it on pieces of boards, bricks, or common drain tiles. Bricks or tile, if six-sided or square, are very commonly used, and answer an excellent purpose. Pieces of board, scantling, or plank may be used; but it is far better to nail them together and place them on the ground edgewise. Shallow boxes without top or bottom, or old discarded shallow hive-supers, are very often employed. The front boards should be a little shallower than the side ones to permit of downward projecting cleats of the bottom-board.

The hive-stands—brick, tile, or boards should be firmly imbedded in the soil in such a way that the front end of the hive will be lower than the back. The purpose of this is to allow the water from



Hive-stand with slanting front.

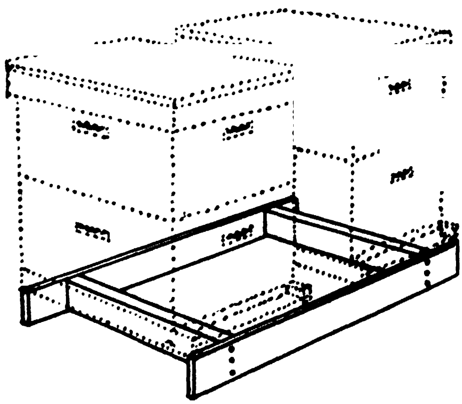
beating rains or from condensation within the hive during winter to run out of the entrances.

The most popular form of hive-stand is here shown. A wood-shop or planing-mill can cut a board through the middle on a

On the Apalachicola River, Florida, where there is danger of high water in the spring, it is necessary to elevate the hives on high platforms beyond any possible danger of flood waters. See cut on the next page.

bias as easily as it can square in two. There will then be two boards, right and left, for the sides. The illustration on previous page shows how it is made.

Some producers use a double hive-stand—that is, a stand after the pattern of the plain single stand, but long enough and wide enough also to take on two hives crosswise, and yet leave a space of six or eight inches between. The illustration shows a design that is very cheap and effective. The front and rear boards are made of one-inch lumber, preferably un-



Double hive-stand.

planed, from three to four inches wide. These two pieces are tied together by a couple of scantling, crosswise as shown. It is advisable to have these last-named pieces back five or six inches from the ends of the sideboards. When constructed in this way, the hive can be placed more nearly over the point of greatest strength, and at the same time allow room for the toes of the operator to project under the hive while working over it.

This form of hive-stand has much to recommend it. It is almost as cheap as the single hive-stand, and yet will accommodate two hives. Colonies worked in pairs on it do very nicely. In the fall, if one of them should be a little weak it is possible to unite them by putting the stronger colony in the center of the hive-stand to catch all the flying bees and then remove the other hive. It is also possible to put a one or two frame nucleus on one end of the hive-stand, leaving the colony on the other end. This nucleus can be used during the season for rearing queens, and at the close it can be easily united with the full colony on the other end, which should be moved to the center of the hive-stand. (See Uniting.)

This double hive-stand lends itself to the plan of wintering when two colonies are put in a winter case; or it will work very nicely when four colonies are put in a single case, provided there are two double hive-stands placed back to back. (See

This shows the substructure of the elevated platforms shown on the opposite page. In place of square timbers, poles cut from trees suitably braced are used and much cheaper.

Wintering Outdoors, subhead Quadruple Cases.) There is one objection to this plan, namely, that the bees are liable to drift. (See Drifting.)

Hive-Stands or Platforms for Swampy Country

Where land is swampy, or liable to be overflowed, as it is in many places in the South, elevated trellises or platforms should be constructed. It is customary to have these long enough to accommodate 100 or 200 colonies. Examples of this form of elevated platforms are shown in the accompanying illustrations.

Arrangement of Hives

The most satisfactory arrangement of the hives can best be decided by studying the plans adopted by some of the prominent apiarists. The lay of the land and exposure to high winds will, of course, have to be taken into consideration.

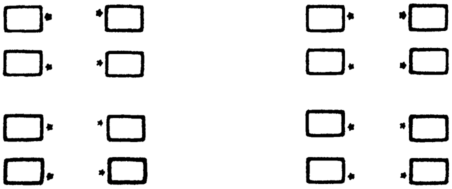
A platform apiary suitable for swamp country.

The usual plan is to arrange the hives in long straight rows, each hive so many feet distant from its neighbor, and on an exact line drawn by a string. While such an arrangement is pretty, it has one serious objection. When hives all face in the same direction, and in straight rows, each hive by itself, the bees are apt to become confused at the entrances, especially if the hives are only two or three feet apart. When the young bees are out at their play-flights, they are liable to join the group where the bees are flying the thickest. The result is, their own colony is depleted while the one that makes the biggest demonstration for the time being is getting more bees than it can easily take care of. This causes some colonies to be too strong, and swarm too early, while the others are too weak, and do nothing all summer. (See Drifting.)

It very often happens, also, that when bees are taken out of the cellar, and put into regular rows they will drift in the same way; and this drifting makes trouble.

This whole difficulty of drifting can be corrected by giving each hive or group of hives an individuality of its own. Where the ground and shrubbery or trees permit, it is desirable to put hives in groups of two, three, or five; two here, three there, five there, and so on. There may be regular groups of two or groups of three, but in either case there should be a bush or tree at or near each group to enable the bees to disinguish one group from another.

If the bees are to be wintered in quadruple winter cases, as described under Wintering Outdoors at the close of this work, the hives should be arranged in groups of four. During the summer the

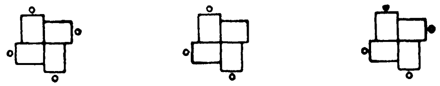


A part of an apiary arranged on the straight-row plan.

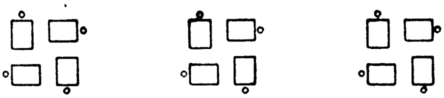
hives are placed from 10 to 15 inches apart; but during the winter they are placed inside of the winter cases close together, back to back and side to side, without any intervening space. They are then packed as described under the head of Wintering Outdoors.

The stars in the illustration indicate the entrances. There are two lanes, or alleyways; one six feet wide for the bees, and one ten feet wide for the apiarist and his truck. It will be noticed that the hives are arranged in pairs, in such a way that they face each other with entrances six feet apart. In the next alley their *backs* are toward each other, with plenty of room for a roadway.

In some localities, especially where the bees are moved very much, it has been found advantageous to place the hives in groups of four by placing the entrances at the four corners, as shown in the accom-



WINTER ARRANGEMENT.



SUMMER ARRANGEMENT.

The hives for summer are placed 12 inches apart. and the groups 8 feet apart. For winter the hives are shoved close together as shown. The objection to the plan is that the operator is sure to encounter the flight of bees. If there is no windbreak on the north, one colony will have its entrance exposed to cold north winds.

panying diagram. With this arrangement there is little less trouble from drifting than where the hives are placed in pairs with entrances side by side. When the bees drift, especially in spring, one colony in the pair may be very strong and the other weak.

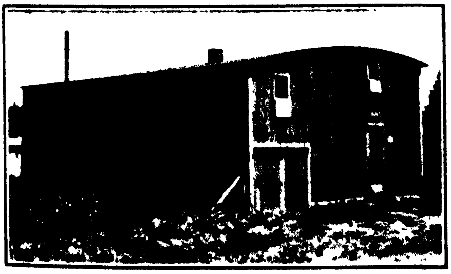
The tendency of late years is not to put the hives in groups of four. It makes the winter case, if of lumber, too heavy to handle.

Keeping Down the Grass at Entrances of the Hives

If the bees are located in a town or city in some back lot it is desirable to have the grass kept down with a lawn-mower, for appearance's sake if nothing more; but in large commercial yards, especially outyards (see Out-apiaries), it is hardly practicable to do this. If the grass or weeds get very long or in the

way, enough to impede travel through the yard, they should be cut with a scythe. During the time when honey is coming in freely it is very important to have the grass kept down for a foot or two around the entrances of the hives, as otherwise bees coming in heavily laden with honey will get tangled more or less while getting to their entrances. At the same time, these obstructions wear out their wings. No good beekeeper can afford to allow the flyway to his entrances to become clogged, and so he should cut away the grass around the entrances with a pair of grass-shears or a sharp sickle; but he should not attempt to do this without first blowing a little smoke into the entrance. Many, however, as a matter of economy of time, prefer to use a rough board of the cheapest lumber, as long as the hive is wide, and from 12 to 18 inches wide. If this reaches from the ground to the entrance it will leave an easy runway for the bees to get into the hive, and at the same time keep away the grass and weeds from the immediate front of the hive. Salt is sometimes used for killing off all kinds of vegetation around the entrances. It must be liberally applied in front of every hive at the beginning of the season.

Sheep are very good for keeping down the grass in the whole beeyard. Unlike cattle or horses they will not knock over a hive; and should they be stung around the face or nose they will push their heads into a bush where they will be perfectly safe. Their heavy coat of wool protects their bodies.



House apiary with hives in second story with extracting plant below.

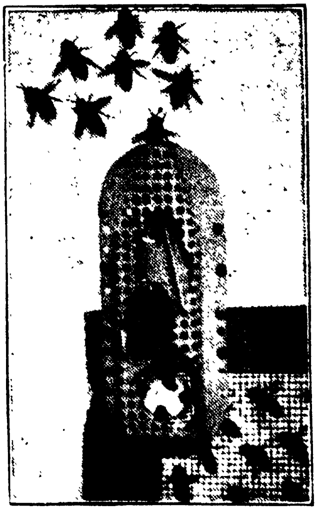
THE HOUSE-APIARY

This is a term that is used to designate a building to enclose a whole apiary. The hives are usually arranged on shelves next to the outside walls and having direct communications with the outside.

As a rule, an outdoor apiary is cheaper and more satisfactory than one in a building. For the house-apiary, the capital to put up the building must be furnished in addition to that necessary to get the hives. But there are conditions under which the building may be and is used to advantage — in fact, affords the only method of keeping bees. Where land is valuable, such as in or near the city, or in localities occasionally visited by thieves or mischievous boys, where bees, honey and everything, so far as possible, must be kept under lock and key, a house-apiary is a necessity. A small building, also, to accommodate 35 or 40 colonies, even when these conditions do not exist, may often be used very advantageously in connection with the regular apiary outdoors. When robbers are bad, or when the day is rainy, the work can continue inside the building because the apiarist can leave the outdoor bees and resume operations inside, free from robbers in the one case, or protected from inclement weather in the other.

How to Construct a House-apiary

The building may be oblong, square, octagonal, or round. The round or octagonal form would, perhaps, save steps dur-



Porter honey-house bee-escape.

ing the operation of extracting; but it is too expensive to construct. It is advisable to put up a plain oblong building. Where

W. C. Sorter's house-apiary. The rags of different colors are used to enable the bees to mark their own entrances more easily.

the winters are cold it should *by all means be double-walled.* Walls should not be less than four inches thick and six would be much better. Sawdust or some sort of packing material should be poured in between the two walls during construction. Unless it is very warmly packed there will be bad wintering.

As to doors and windows, in the case of a small building 20 by 30 feet there should be only one window, and that opposite the door, so as to allow a draft to pass directly through, because the building at best becomes very sultry in hot summer weather. An ordinary tight-fitting door should be used, hinged in the usual way. To the outside of the door frame there should be a self-closing wire-cloth screen door. At two of the upper corners of the doors and windows, for the escape of bees clustering on the wire cloth, attach Porter honey-house bee-escapes, as shown on the previous page.

At several points, close on a line with the floor, should be one-inch holes, on the outside of which should be more Porter honey-house bee-escapes. The purpose of the openings in these escapes is to let the bees that happen to be inside after handling crawl out toward the light; and, once outside, they will enter their own hives, with the possible exception of a few young ones, and they will be accepted at any of the entrances.

A few years ago it was the practice to make compartments as a part of the building to hold the frames, but this was found to be very objectionable; and those who manage house-apiaries now prefer to use ordinary outdoor hives instead, primarily because the bees can be more easily confined to the hives; and, secondly, because the indoor and outdoor hives are one and the same, and interchangeable.

The hive entrances should be so arranged that they communicate with openings through the side of the building. Ordinary covers should be used to confine the bees strictly within the hives. In lieu of a cover a ⅜-inch board, or inside super cover, may answer just as well; but, so far as possible, the house-apiary should be so constructed that everything outdoors may be moved inside, and vice versa, whenever requirements make it necessary.

When the building for a house-apiary is double-walled, it is necessary to provide some sort of bridgework or housing to cover the runway between the entrances of the hives inside and the openings outside. In the author's original building a two-inch round tube was used, because it was easier to insert a tube

than to make a narrow rectangular box or housing. But a round hole as large as this is not as desirable as a covered runway through the side of the building to the regular entrance of the hive.

Putting Cross Colonies in House-apiaries

The crossest bees are but little inclined to sting inside of a building. When they fly from the combs that one is handling, they find themselves inclosed; and this so disconcerts them that they immediately fly to the screen windows and escape. James Heddon said, "If you have a cross colony, put it in the house-apiary and see how tame it will become."

House-apiaries for Wintering

As the building is double-walled, and is (or ought to be) packed, colonies will require less protection than outdoors. Indeed, about all that is necessary to put them into winter quarters is to put on an extra comb-honey super, tuck in a chaff cushion, and replace the cover, when the bees will be prepared. In very severe cold weather a small fire, or heat from a large lamp in the room, may perhaps be used to advantage; but artificial heat in wintering should be used sparingly and with care for oftentimes it does more harm than good. (See Artificial Heat.)

APIARY, OUT.—See Out-Apiaries.

APIS DORSATA.—See Giant East Indian Honeybee under Races of Bees.

ARTIFICIAL FERTILIZATION OF QUEENS.—See Fertilization of Queens by Artificial Means.

ARTIFICIAL HEAT.—As strong colonies early in the season are the ones that get the honey and furnish the early swarms as well, and are in fact the real source of profit to the beekeeper, it is not to be wondered at that much time and money have been spent in devising ways and means whereby all colonies may be brought up to the desired strength in time for the first yield of honey. As market gardeners and others hasten early vegetables by artificial heat, or by taking advantage of the sun's rays by greenhouses, it would seem that something of the kind might be done with bees; in fact, the author, by the aid of the heat of a stove, has succeeded in rearing young bees every month in the year in a greenhouse, even while the weather outside was at zero or lower; but the scheme resulted in failure, so far as profit was concerned. The bees, it is true, learned to fly under the glass and come back to their hives; but for every bee that was raised in confinement, two or three were sure to die from one cause or another.

Experiments have been conducted on a large scale at Ashtabula, Ohio, where there are about 40 acres under glass. The owner of one of the large greenhouses tried out the experiment of seeing what he could do in raising bees in a spring or summer temperature under control. He noted that they pollinated his cucumber blossoms; and if he could raise bees under glass he could recuperate his loss by raising a fresh supply of bees during the months when he was raising cucumbers. The experiment of raising bees was a failure, but the pollinating of the blossoms was a perfect success. (See Bees for Pollinating Cucumbers under heading Fruit Blossoms.)

At another time experiments were made with artificial heat while the bees were allowed to fly out at pleasure; and, although it seemed at first to have the desired effect so far as hastening brood-rearing was concerned, the result was, in the end, just about as before; more bees were reared, but the unseasonable activity killed off twice as many as were reared, and the stocks that were let alone in the good old way came out ahead.

Attempts have been made in the way of using small electric heating coils or electric bulbs for house lighting in the top of individual colonies under packing for the purpose of holding an even temperature in the hive irrespective of outside weather conditions. The colonies immediately went to brood-rearing; but, as might be expected, breeding always forced the bees out of the hive for water and pollen. Of course, they could not fly far in a freezing temperature, and they died. All attempts to heat individual colonies by means of electricity, like all similar attempts, have ended in failure.

For the benefit of those who may be inclined to experiment, the senior author, A. I. Root, covered almost his entire apiary one spring with manure on the plan of a hotbed, and had the mortification of seeing nearly all the bees die of spring dwindling. Another time he kept the house-apiary warmed up to a summer

temperature with a large oil lamp, for several weeks, just to have them beat those out of doors. The experiment resulted in losing nearly all the house-apiary bees with spring dwindling, while those outside stayed in their hives, as honest bees should, until settled warm weather, and then did finely, just because he was "too busy to take care of them" (?), as he used to express it.

Wintering Bees in a Warm Room

But a number have wintered single colonies of bees in the living-room of a house where the temperature was kept between 65 and 72, night and day. In the cases mentioned, the colonies were placed on a shelf next to a window, with the entrance communicating with the outside. All old and superannuated bees can thus escape at any time, and when the weather is suitable the bees can fly. A colony of bees was placed in one of the offices of The A. I. Root Company and was there for at least three years. Some years it seemed to winter very nicely; but taking one year with another, these indoor colonies did not seem to get ahead like those outdoors. The warmer atmosphere in which the hive is placed has a tendency to start brood-rearing. This forces the bees out on unfavorable days, with the result that they never return. The slight amount of brood hatched does not compensate for the number lost in this way; and the result is, the colony gradually goes down. By the time spring comes on the queen is not ready for the active duties of the hive, for the simple reason that she has been laying more or less all winter; and probably, if she were a human being, she would say she was "all petered out."

Packing the hives with chaff, sawdust, or any other warm, dry, porous material, so as to economize the natural heat of the cluster, seems to answer the purpose much better, and such treatment seems to have none of the objectionable features of working with artificial heat. The packing needs to be as close to the bees as possible; and to this end all the combs should be removed except such as are needed to hold their stores. Bees thus prepared seem to escape the ill effects of frosty nights in the early part of the season, and exactly what was hoped for by the use of artificial heat is accomplished for brood-rearing.

By turning to the general subject of Temperature, it will be seen that artificial heat or a sudden rise in temperature has a tendency to start brood-rearing in a colony. Ordinarily it requires something like 95 degrees Fahrenheit in the cluster for the rearing of brood. When this point is reached, no matter what the outside temperature may be, brood-rearing will be started; but when the temperature outside is below freezing, so that the bees can not fly, artificial heat does much more harm than good, because brood-rearing in midwinter usually spells disaster for the colony before spring. During open winters, however, especially if the colonies are well packed, and toward spring, breeding does no harm. If a colony is of normal strength it will raise brood as soon as it can safely. To stimulate brood-rearing by means of artificial heat is always a mistake. By reading the whole article on Temperature elsewhere in this work one will understand why this is so.

For a further consideration of this subject see Temperature and Building Up Colonies.

ARTIFICIAL PASTURAGE.—Although there was formerly quite a trade in seeds and plants, to be cultivated for merely their honey alone, little encouragement can be given to those who expect to realize money by such investments. There is certainly a much greater need of taking care of the honey that is almost constantly wasting just for lack of bees to gather it. A field of buckwheat will perhaps occasionally yield enough honey to pay the expense of sowing, as it comes in at a time when the bees in many places would get little else; and if it does not pay in honey, it certainly will in grain.

Alfalfa, sweet clover, alsike clover, and vetch afford the best examples of artificial pasturage of anything known. But neither sweet clover nor alfalfa will grow everywhere—at least not until the soil has been put in the right condition with proper inoculation.

Sweet clover furnishes an artificial as well as wild pasturage, and is now being grown as a regular farm crop. In many portions of the West where the land is too dry to grow alfalfa, sweet clover will thrive. In many parts of Kentucky, Kansas, Nebraska, North and South Dakota, Oklahoma, Indiana, Illinois, Michigan,

Missouri, Ohio, and, in fact, almost all northern states sweet clover is coming to be a very profitable crop, and along with it the business of producing honey has developed. It often does well on land that will not grow anything else, especially on rocky hillsides. (See Sweet Clover.)

Vetch in many of the southern states east of the Mississippi is being sown largely either alone or with oats for hay. When the oats are cut in the milk a fine hay is produced; but when the vetch is grown with it, a much better hay is furnished. Vetch alone is fine for cows and most excellent for bees. The honey is white, of good body and flavor. As vetch will grow on an acid soil, it is from the standpoint of hay and honey for the South what sweet clover is for the North on a sweet soil.

Alsike clover also furnishes artificial pasturage in the eastern states. It often takes the place of ordinary red clover that fails to do well. Alsike can stand wet feet, but red clover will not. This discovery has caused many farmers to grow it either with timothy or exclusively, and the result is that wherever it is extensively grown the keeping of bees is profitable.

In general, it may be said: Plant and sow all that will be sure to pay aside from the honey crop, and then, if the latter is secured, you will be so much ahead; but beware of investing much in seeds that are for plants producing nothing of value except honey. Alsike, white Dutch clover, sweet clover, vetch, buckwheat, rape, alfalfa, and the like, it will do to invest in; but catnip, mignonette, Rocky Mountain bee-plant, etc., should be handled rather sparingly.

The question, "How many acres of a good honey-bearing plant would be needed to keep 100 colonies busy?" has often been asked. If 10 acres of buckwheat in full bloom would answer, perhaps there would be needed 10 other similar fields sown with sweet clover, vetch, crimson clover, blossoming at as many different periods, to keep them going the entire warm season. Alfalfa, sainfoin, sweet clover, vetch, buckwheat, rape, alsike clover, crimson and red clover, cowpeas of the South, and some others, are the only cultivated plants that unquestionably have given paying crops of honey. (See Honey Plants.)

ARTIFICIAL SWARMING.—Artificial swarming, sometimes called "shook swarming," was practiced more a few years ago than in later years. It is the act of creating conditions within the hive comparable to those of a colony about to swarm. For those who may be away from the apiary at swarming time, it may be used especially for the production of comb honey. Business and professional men, by a little attention to their bees once a week during the swarming season, may by this means anticipate swarming, thus forcing the swarm at the convenience of the beekeeper instead of permitting the colonies to swarm when they get ready, usually at the most inconvenient time. Extensive honey producers who operate several apiaries can control swarming by visiting each apiary about once a week and making artificial swarms when colonies are found that are preparing to swarm. Before the reader takes up this subject he should read carefully the article on Swarming in order that he may understand the conditions that bring about swarming in a natural way. He will then be in better position to understand the principles involved in *artificial* swarming.

It is not considered a good practice to make artificial swarms from colonies that are not making preparations to swarm naturally, for colonies which are willing to work well throughout the season without swarming should not be disturbed by swarming them artificially. As a rule, the bees do not swarm naturally until the first of the queen-cells built preparatory to swarming are capped, or about ready to be capped. By examining the brood-combs of each colony once a week to see if queen-cells have been started, it is possible to detect which colonies may be expected to swarm within the next seven or eight days and these may be swarmed artificially.

Small queen cells just started give as good an indication of intention to swarm as those that are capped over. Such small initial queen cups, unless they contain an egg or a small larva, mean nothing, and should not, when empty, be considered an evidence of intention to swarm.

Italian bees sometimes swarm before the queen-cells are capped, and in extreme cases they may swarm almost immediately after starting queen-cells, but this does not often happen. For this rea-

son it is well, if much swarming is expected, as in producing comb honey, to clip the queen's wings, even when artificial swarming is practiced, to prevent the loss of swarms that may issue before the next weekly visit to the apiary. Bees do not often postpone swarming long after the first queen-cells are capped, unless they are prevented from swarming by adverse weather.

When making these examinations, if queen-cells are found which contain only eggs or very small larvae, these cells may be destroyed and the colony left another week. Sometimes they will give up swarming when this is done, but often they build more queen-cells immediately and will be ready for treatment at the time of the next visit a week later. When destroying queen-cells in this way it is necessary to shake most of the bees from the combs to be sure that none of them are overlooked; for, if one is left, a swarm may issue before the next visit.

When queen-cells are found that contain large larvae there is no use destroying these, expecting the colony to give up swarming, for destroying such queen-cells usually does not prevent swarming. When well-advanced queen-cells are found the colony may be treated at once if there is a honey flow at the time. If the bees prepare to swarm before the beginning of the main honey flow, they can usually be induced to give it up by destroying the queen-cells and giving a second story of empty combs, especially if some of the combs of brood are raised up into the second story.

The operation in artificial swarming, in brief, is as follows: The old hive is moved to one side of its stand and an empty one, just like it, is put in its place. In this hive are placed frames having foundation starters or full sheets of foundation, preferably the latter. If neither of these is available, frames of empty combs may be used, especially if the colony is run for extracted honey, but a full set of empty combs is not best for comb honey. Most of the bees, including the queen, are then shaken or brushed from the combs in front of the entrance of the new hive so arranged that they will run into the hive readily; or, if preferred, they may be shaken on top of the frames in the new hive. Some prefer to find the queen and set the comb on which she was found into the new hive, first being sure that it contains no queen-cells; some find the queen and run her in at the entrance of the new hive; while others shake and brush all the bees without looking for the queen. Whatever the method employed, the queen must be in the new hive when the operation is complete.

If comb honey is being produced, usually two combs with adhering bees should be left in the old hive so that there will be enough bees to take care of the brood. The number of bees necessary to leave in the old hive for this purpose depends upon the weather, more being needed if the nights are cool. The combs containing the finest queen-cells should not be shaken if increase is to be made from the parent colony, since shaking the combs injures the immature queens in their cells. The queen-cells on all the other combs which have been shaken should be destroyed to prevent any crippled queens emerging; for such a queen, if she emerges first, might destroy the perfect young queens in their cells on the unshaken combs.

The supers from the parent hive are next put on the new hive, and the hive of the parent colony is placed by the side of the new one, with its entrance facing in the same direction but having its entrance contracted. The bees should now continue work in the supers and rush the incoming nectar above, especially if foundation is used in the new brood-chamber, for until this is drawn out into comb there is no place to store it below.

The hive containing the parent colony is left beside the new one a week. Then at a time when the bees are working well in the fields, and preferably while many young bees are taking their playflight (See Playflights of Bees), the old hive should be moved to a new location for increase. The old hive should be handled carefully while being carried away to prevent disturbing the bees, so that when the field bees that are in the hive go out after another load they will not note the change in location of the hive. The hive should be carried far enough away so that the returning bees will not find it. It should not be located too close to other hives where bees from an adjacent hive might enter it by mistake. When this is done most of the young bees which have become field workers during the week will now, as they return from the fields, enter the new hive on the old stand, and at the same time

the parent hive will be so depleted of its bees that after-swarming is prevented. (See After-Swarming, Second Method.)

If extracted honey is being produced, all the bees may be brushed or shaken from their combs and allowed to run into a new brood-chamber containing foundation or combs. On top of this is placed a queen excluder. Over this are placed the supers and the old brood-chamber with its combs of brood and any queen-cells it may contain. When the combs of brood are shaken and brushed clean, it is not necessary to find the queen to be sure that she is in the new brood-chamber.

In this way the parent colony is above the supers and the swarm is below the supers, both being in the same hive. They are, in fact, a single colony with the young and emerging bees in the upper hive-body and the queen and the new brood-chamber now being established in the lower hive-body. As the brood emerges the combs in the upper hive-body will be filled with honey and the former brood-chamber now becomes a super. It may be advisable again to destroy all queen-cells in the old brood-chamber 10 days later, though this is not always necessary, especially if several supers are between the lower brood-chamber and this one on top. If increase is desired the queen-cells should not be destroyed, and the old brood-chamber with its emerging brood should be taken away a week after the artificial swarm is made and used for increase.

The question may be asked here why this method is not recommended when producing comb honey. To place the old brood-chamber above the comb-honey supers would result in the cappings of the comb honey being discolored; and, unless the honey flow is quite rapid, too much of the honey would be stored in these brood-combs as the brood emerges, causing bees to neglect the comb-honey supers.

Some have reported success by placing the old brood-chamber with its emerging brood on top of the comb-honey supers but with a ventilated bee-escape board between. By doing this the brood is kept warm by the heat passing through the wire cloth in the escape-board, and the young bees passing through the bee-escape are added to the colony below.

Various devices have been used to cause the young bees of the parent colony to unite with the swarm; such as cone escapes or tin tubes over the entrance of the parent hive which lead the bees to the entrance of the new hive, so that when the young bees go out for their first flight they do not find their way back into their own hive but enter the new one. In this way the emerging bees of the parent hive can finally all be added to the swarm; but the simpler plan of moving the parent hive to a new location is more commonly used.

Instead of moving the old hive away when making an artificial swarm, the bees may be shaken back into their own hive, and the combs of brood placed in another hive which is now to house the parent colony.

If only frames containing foundation are used for the bees shaken, the bees may swarm out and desert their hive the next day or even two or three days after the artificial swarm was made. To prevent this, it is usually better to remove only a part of the brood at first, leaving from one comb up to half of the combs of brood, being sure that no queen-cells are left. Frames of full sheets of foundation are then put in to take the place of the removed brood. Two or three days later, when the foundation is well drawn out, the remaining combs of brood should be removed. Even when but one comb of brood is left to discourage swarming out, it should be removed within about three days; for, if the bees are well along in their preparations for swarming at the time of making the artificial swarm, they may immediately start queen-cells on this comb of brood, and sometimes swarm even when most of the brood has been taken away.

Combs of honey are sometimes used on which to hive artificial swarms. If this honey is unsealed, the bees usually carry it above promptly; but if combs of sealed honey are used the bees are not inclined to move it up promptly, and they may work with less vigor when much sealed honey is in the brood-chamber.

Under the head of Dividing and Nucleus the question of various methods for increasing the number of colonies by dividing or otherwise is taken up. The readers should understand that "artificial swarming" is one thing, and "increase by dividing" is entirely another. The former is used to prevent natural swarming, or, rather, to put it at a time to suit the convenience of the beekeeper and yet get a

crop of honey. The latter does not contemplate the idea of securing honey, but rather an increase in the number of colonies.

Under the head of Demaree Plan of Swarm Control and under the general head of Swarming, subhead Prevention of Swarming, are discussed methods for control of swarming without shaking. In a quick honey flow the shaking plan is preferred, but in a long honey flow one of the Demaree plans will give better results.

ASTER.—(*Aster*, the Greek word for star.) Asters are also called starworts, and in England Christmas daisies, from their late period of blooming. This is a genus

Aster.

of the Compositae, the largest and most important plant family, to which also belong the goldenrods, sunflowers, thistles, and daisies.

Aster honey is gathered chiefly from the very common species *A. multiflorus*, *A. vimineus*, *A. lateriflorus*, *A. Tradescanti*, and *A. paniculatus*, all of which produce dense clusters of small white or pale blue-white-rayed heads, except *A. multiflorus*, which has the rays white or purplish. Over large areas in Kentucky, Indiana, and other states the bloom is so abundant that the fields look as if covered with snow. The plants are often very bushy, growing from six inches to three feet tall. When the weather is favorable colonies will pack their combs with aster honey, or if combs have already been filled from an earlier source a surplus is often stored.

Pure aster honey is white—as white, according to beekeepers familiar with it, as white-clover honey; but it is seldom obtained pure. Usually it is colored amber or yellow by honey from goldenrod or other late-blooming autumn flowers. The asters, however, remain in bloom longer than the goldenrods. When newly gathered the honey has a rank odor, but this disappears when it has ripened. It has a pleasant aromatic taste, and is so thick that at times it is extracted with difficulty. It crystallizes quickly with a finer grain than goldenrod. It has been stated to be unsuitable for table use, but O. H. Townsend said that in Michigan he sells aster honey for the same price as red raspberry, and that it has a fine flavor and good body. Other beekeepers also describe the flavor as from agreeable to a little off.

Many beekeepers have complained that their colonies suffered more or less loss when wintering on aster honey. So strong has been the opposition to it for this purpose that its removal and the replacing of the stores by feeding sugar syrup have been repeatedly advised. It is not improbable that aster honey gathered so late that it only partially ripens and remains unsealed is liable to deteriorate and become deleterious before spring; but any other honey or even sugar syrup under similar conditions would be objectionable. Its tendency to candy quickly and solidly, making it only partially available to the bees, has also added to its poor reputation as a winter food. Mismanagement on the part of the apiarist seems likewise in some instances to have been laid to the fault of aster honey. But if this honey possessed properties that were actually injurious to bees, they would appear uniformly everywhere, but this is not the case. The experience of scores of beekeepers, continued through many years, proves that aster honey *well ripened and sealed* is an excellent winter food for bees.

In a symposium, published in Gleanings in Bee Culture August 15, 1915, many beekeepers testified that they had wintered bees successfully year after year on

Aster paniculatus.

Aster multiflorus.

Aster tradescanti.

Aster puniceus.

aster honey with very little loss. It has been suggested that perhaps different species of aster yield different kinds of honey; but there is no ground for such a supposition. On the contrary, the nectar of the various species, as in the case of the goldenrods, is very similar.

In Georgia several species of aster (the most common are *A. adnatus* and *A. squarrosus)* grow all over the state, and in many places are the main reliance for winter stores. In a few localities a surplus is obtained. The honey is medium in quality, of fair color, but candies quickly in the comb if not sealed. The blooming time is from September to November.

B

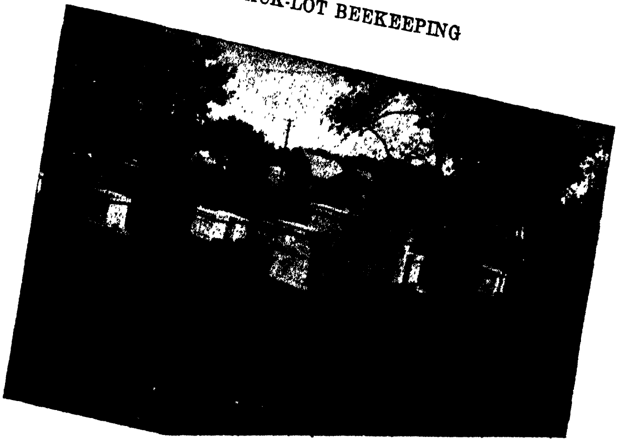
BACK-LOT BEEKEEPING. — A very large number of those who keep bees are those who might properly be called back-lotters — those who live in cities and towns and who keep a few bees in connection with a few chickens or a little garden. The back-lotters comprise professional and business men, as well as women and children of their families. Included in this class might be also the farmers' wives who have a few colonies to pollinate fruit trees, and who likewise desire recreation, amusement, and a little money on the side for the family. Bees will earn

Upper—H. W. Large, Columbus, Ohio, enjoys his little apiary even in winter. Lower—Mr. Large and his daughter who sells the honey.

as much money as chickens and often do much better.

Back-lot beekeeping does not differ greatly from the keeping of bees on a large scale except that there are no outyards, no expensive moving-truck and elaborate extracting-outfits, and no hired help. The back-lotter, primarily, whether man, woman, or child, is one who desires to take up some form of amusement or recreation—something that will keep him outdoors and something that will take up his time while he is out of the store, office, or shop. If the back-lotter happens to be an overworked business or professional man, he will surely need some line of diversion—something that will rest his mind by taking it from his business or profession and allowing it to rest and recuperate in new lines of thought. Why not beekeeping? (See Beekeeping for Women.)

While there are those who take up the hobby of kodaking or taking pictures, of running a little garden, or keeping a few chickens, the number of those who are taking up bees in a small way is increasing very rapidly. The average back lot in the city will not permit of a very extensive garden—in fact, in most cases no garden at all. The chicken business is liable to cause trouble with the neighbors, especially if the chickens fly over the fence and scratch up Mrs. Neighbor's posy bed. While bees will not scratch up gardens they may soil Mrs. Neighbor's wash on the line; but a box or two of honey in advance will so sweeten her up that she will tolerate any inconvenience of this kind, which fortunately occurs only about once a year. After bees have been confined in a cellar for the winter, they discharge their liquid feces on their first flight on the white linen if it happens to be on the line at the time; but a rinsing of the clothes will make them as clean as before, and a pail or box of honey will do wonders in advance by



BACK LOT BEEKEEPING

Upper—Back lot apiary of Geo. W. Meyer, McElhattan, Pa. Middle—Back lot beekeeping in West Virginia, property of R. M. Apitzsch, Hollidays Cove. Lower—Chas. J. Krug's back lot apiary, Chattanooga, Tennessee.

A back-lotter who has bees for pollinating purposes. Mr. J. B. Pierson, Gastonia, N. C., keeps a few bees to pollinate his mixed planting of sweet clover, red clover, alsike and lespedeza.

sweetening up feelings that would otherwise be sour. The neighbor should be advised not to hang out her clothes just after the bees are set out of the cellar in the spring. Or, better, the beekeeper should not put the bees out till after wash-day.

But the objection may be made that bees may sting the neighbor's children. While this may happen, such occurrences are not common. If one will follow the plain and simple directions for handling bees, there will be no trouble. There are back-lot apiaries in all of our large cities (and even on the roofs of some large office buildings)—hundreds and hundreds of them; and when we consider the back-lot apiaries in the smaller towns, their number can be measured by the thousands; and yet out of all these thousands of little apiaries it is only about once in four or five years that we hear of a single case of trouble, and only once in about 25 years that resort is had to the courts. (See Laws Relating to Bees and Bees as a Nuisance.)

The danger from stings may be averted by reading carefully the articles on Apiaries, Robbing, Stings, Bee-smokers, and Manipulation of Colonies — particularly the last named. There is no good reason why any back-lotter should stir up his colonies to a furious stinging. If he will

A. G. Fisher's back-lot apiary, the surplus honey from which was traded for farm products.

carefully inform himself by reading the articles mentioned, his next-door neighbors will never know he has any bees except as they may see the hives and the bees flying out to the fields. If he will take the further precaution to give those neighbors a box of honey now and then, they will be willing to overlook any occasional annoyance resulting from a lack of experience and mismanagement.

In most of our northern cities white clover thrives on lawns. No matter how dry the season, the constant sprinkling and mowing keep white clover in bloom for a much longer period than the average pasture lot. Besides white clover, sweet clover is being grown extensively along railroad embankments, in waste fields, and lots unoccupied, that are being held until a suitable price can be secured.

Small-fruit trees and the clovers in the back yards of our cities afford some pasturage in the spring when they are in bloom. The ever present dandelions, that are an irrepressible nuisance on almost all lawns in the North, also afford pollen and honey. (See Dandelion.)

We have known some back-lotters to secure two or three hundred pounds of honey per colony. As the market is right at hand much of the honey can be sold at retail without sharing the profits with middleman. Back-lot beekeeping, therefore, offers exceptional opportunities for making a little money on the side as well as securing an unlimited amount of pleasure and a new field for thought in the realm of nature.

BAIT SECTIONS.—See Comb Honey, to Produce.

BALLING OF QUEENS.—See Queens, Queen-rearing, and Introducing.

BANAT BEES.—See Races of Bees.

BARRELS. — Many years ago barrels and kegs were used almost exclusively for the shipment of honey in bulk. While they are still being used in certain parts of the South, they have largely gone out of use and the 60-pound square cans, two of them to a case, have taken their place. (See Extracted Honey and Cans.)

Anything made of wood is sure to shrink and swell under different climatic conditions, and it is right here that the wooden package for honey has caused much trouble between the shipper and the buyer. Unless barrels or kegs are well made of *dry, sound* timber, and unless they are *well coopered,* they are inclined to leak. When a barrel or keg containing honey is shipped from a moist climate into a dry one the staves shrink and the honey will ooze out between the staves. The employees of the railroad company are not interested in driving down the hoops and sometimes the barrels will be covered with a smear of honey, attracting insects, especially flies and bees. The metal containers in the form of square cans are not affected by weather conditions. While they cost slightly more per pound for the package, the honey goes through to destination in much better condition.

In all carload shipments square cans are used almost universally now. For less than carloads, barrels and kegs are sometimes used in some of the southern states. Kegs were formerly used in the northern states, but because the buyer very often refused to accept shipments of honey in them, they have practically gone out of use throughout the North.

Caution on the Use of Barrels

Use only new barrels or kegs. The wood must be well seasoned before it is coopered up, and even then the inside of the keg or barrel should be coated with paraffin or wax. Honey contains, on an average, from 17 to 20 per cent of water; and unless the barrels are previously coated the wood will absorb a considerable amount of water. While the barrels may not leak, the buyer will complain because the honey is short in weight.

Before barrels are filled with honey, the hoops should be driven down as far as they will go. The staves should be bone-dry inside and out. Never pour water into the barrel to make the wood swell for the purpose of closing leaks. As soon as honey is put in it will absorb the moisture and the barrel will leak.

To coat the barrel on the inside, melt ten or twelve pounds of paraffin, pour it in the bung of the barrel, drive the bung in place quickly, and roll the barrel on one end, then on the other. This operation will warm the air inside to such an extent that the hot liquid will be forced into every crevice, and at the same time coat the wood. As soon as the barrel with this hot liquid has been rolled around

enough, loosen the bung with a hammer. If the work is well done the bung will be blown into the air with a loud report, and the remaining liquid can be poured out to be remelted and used for another barrel.

In coating the inside of a barrel with paraffin or hot wax, be sure that it is tight before waxing. This can be determined by using an automobile tire-pump and pumping air into the barrel to see where there are any leaks. These can be located by a hissing sound, and quickly closed by driving the hoops down still further.

Another way to test for leaks is to place the mouth over the bung and suck out the air until the lips are drawn tightly over the bung; then wait a few seconds, and if the suction still holds the barrel may be considered tight.

Removing Granulated Honey from Barrels

Good thick honey will usually become solid at the approach of frosty weather, and perhaps the readiest means of getting it out of the barrel in such cases is to remove one of the heads and take it out with a scoop. When it is quite hard, one may at first think it is difficult to force a scoop down into it; but if he presses steadily and keeps moving the scoop slightly, he will soon get down its whole depth. If the barrel is kept for some time near the stove, or in a very warm room, the honey will become liquid enough to be drawn out through a large-sized honey-gate.

A more efficient way of removing candied honey is to set the barrel or keg in a tub or wooden tank of water, the latter being kept hot by a small steam pipe. In 24 or 36 hours the honey will be melted, and can then be drawn out in the usual way.

BASSWOOD.—This tree is not a dependable source, but it is seldom that it fails entirely to yield nectar. Even when the trees are laden with flowers if the weather is cold, cloudy, and windy, no surplus will be obtained. Hot clear weather and a humid atmosphere are the conditions most favorable for the active secretion of nectar. Small drops may then be seen sparkling in the bloom, and a bee may at times obtain a load from a single blossom. The best yield of honey at Medina, Ohio, ever secured from a single hive was from basswood bloom, the quantity being 43 pounds in three days. The best ever recorded from clover was 14 pounds in one day. At Orchard, Iowa, a yield of 600 pounds of basswood honey from a single colony in 30 days was once secured, an average of 20 pounds per day. A colony at Borodino, N. Y., stored 302 pounds in ten days, and an average of about 55

Basswood in full bloom.

pounds per colony has been obtained for 30 years. The length of the honey flow from basswood may vary from five to twenty-five days; while the date of blooming is influenced by locality, altitude, and temperature. The date of blossoming may be 10 or 15 days later in a cold season than in a hot one. In localities where basswood grows both in the valleys and on high hills the bees will have a much longer time to gather the nectar, since the trees in the lowlands will bloom earlier than those at a greater height.

Basswood honey is white and has a strong aromatic or mint-like flavor. It is easy to tell when the blossoms are out by the odor about the hives. The taste of the honey also indicates to the beekeeper the very day the bees begin to work on the flowers. The honey, if extracted before it is sealed over, has so strong and distinctive a flavor as to be disagreeable to some persons. The smell and taste have been likened to that of turpentine or camphor — not pleasant when just gathered; but when sealed over and fully ripened in the hive almost every one considers it delicious. A pure basswood extracted honey, on account of its strong flavor, should be blended with some honey of milder flavor, as, for example, that of mountain sage or clover.

The illustration shows the appearance of basswood flowers and leaves. The clusters of from five to fifteen flowers are drooping, thus protecting the nectar from the rain. The stem of the cluster is adnate to an oblong membraneous bract. The nectar is secreted and held in the fleshy sepals; and it is often so abundant that it appears like dewdrops in the sunlight. The blossoms are small, light yellow, and exhale a honeylike fragrance. The stamens are numerous, and the anthers contain a small amount of pollen, but honeybees seldom gather it when the nectar is abundant; if, however, the nectar supply is scanty, then both honeybees and bumblebees may be seen with little balls of pollen on their thighs. In England basswood seldom sets seed. The inner bark is tough and fibrous, and was once used by agriculturists and florists for binding purposes.

The basswoods have been so cut off during the last few years for packing-boxes and furniture factories that basswood honey has almost disappeared from the market.

BEE BEHAVIOR.—Behavior is a term used to describe the activities of animal life, whether induced by external or internal causes. Under this head will be described some of the various life activities of the bees, particularly those which have more or less to do with the practices of bee culture.

The Larval Bee

On the hatching of the egg the tiny larva wriggles and twitches much as does a caterpillar when poked with a straw. Almost at once it is supplied with food by a "nurse" bee. This part of the life of a larva has not received sufficient study to warrant any definite statement as to the frequency of the feeding, the amount supplied, its possible varying quality, etc. It must suffice now to say that the periods of feeding seem to be irregular and the amount of food received by different larvae varies largely.

When the larva has completed its feeding period and has stretched out to its full length in the cell, the bees proceed to seal the cell. There are some exceptions to this when the larvae are left unsealed, though the cell walls are slightly extended and the opening contracted. Beekeepers speak of this as "bareheaded brood," and it often causes the novice much concern. (See Brood and Brood-rearing.) The condition has been ascribed to excessive heat; but as it occurs at other times than during the hot weather, and as some colonies seldom or never have brood in such condition while others almost always do, it is reasonable to look upon it as a congenital trait. In some cases uncovered brood is due to the work of the wax worm; but such brood looks very different and is always in the path of the worm's work.

After a brief rest the bee larva begins spinning its cocoon. Slowly the head turns from side to side and back and forth, gradually reaching the middle of the cell; and slowly doubling on itself, the larva extends its work to the base and lies at full length reversed in the cell. Before its labors cease, however, it resumes the former position of its head toward the outer end.

In the case of the queen larva, the spinning begins and proceeds in the same way, but when she is reversed in the cell she reaches as far up as she can, but that is not to the base; and, as she can not

climb, there is no silken web on that part of the cell.

When spinning has ceased, the larva turns on its back and lies still. The changes which follow take place so slowly that only after considerable intervals are the results noticeable. When the metamorphosis is virtually complete (see Brood and Brood-rearing), there is seen in place of the larva a bluish-white bee lying motionless on its back.

The only appendages seemingly missing are the wings. Careful examination will reveal each pair folded up in a little case (pellicle), which lies against the side of the thorax between the first and the second pair of legs.

The first sign of coloring is seen on the ends of the antennae, then on the eyes and feet, and gradually it extends over the whole body. As the time approaches for the bee to emerge from the cell slight tremors are to be seen in the feet and legs, or an antenna moves. About the beginning of the last day the encased wings begin to quiver and move. Slowly they turn until they lie under the bee and at once they unfold. As soon as this occurs, the bee turns over and begins to cut its way out.

The Young Bee

Almost as soon as out, it begins to move over the surface of the combs; and when it comes to a cell of honey it enters and eats. Soon after emerging from the cell, the young bee commences to comb itself and this procedure continues more or less steadily for a day or more. At this tender age the insects' vision seems to be very imperfect. Also, it is unable to fly; and, if tossed into the air, it makes no attempt to use its wings. This function appears only at a later age. Drones, queens, and workers all spend the early hours of their life in much the same way, except that queens seem to be able to fly sooner than workers. Probably queens most precocious in this way have been held in the cells longer than normally and have matured there.

The color of the young bee deepens with age. When they first emerge they are much lighter in color than a day or two later. This difference is more noticeable with queens than with workers or drones.

Home Labor of Bees

The first duty of the worker is the feeding of the larvae, and then a little at a time it extends to pollen-packing, propolizing, comb-cleaning and repairing, honey-ripening, and comb-building.

Co-operation

There is probably nothing in all animated creation that shows such a spirit of co-operation as a colony of bees. There is no king-bee, boss, or ruler. As is well known, the queen herself is little more than an egg-laying machine. She does not direct the policies of the colony, except perhaps in sometimes leading forth a swarm, and even then it is generally believed that she follows rather than precedes the swarm. As noted in several places in this work, the queen not only has her special duties, but the worker bees themselves are divided into two main groups—the house or nurse bees and the field or control bees. The latter, under normal conditions, do little or no work in taking care of the young, building comb, or, in fact, anything else that young bees can do as well or better. The young or nurse bees, on the other hand, do not, as a rule, go to the field until they are from ten days to two weeks old. Soon after they emerge from their cells and get over that feeble, downy look, they begin feeding the young larvae, polish out the cells where the queen can lay, build comb, clean house, carry out the dead, and guard the entrance. The division of labor is so perfectly accomplished that every bee seems to know its own work and does it.

After the active season is over, during which there is little or no brood-rearing and no nectar coming in, all the bees seem to hang over the combs in a sort of listless, quiescent state. As the weather becomes cold, they form in a cluster, as noted under Temperature of the Honeybee Cluster, and under Wintering.

Colony Morale

Demuth, Pettit, and others have shown that some colonies will gather very much more honey than other colonies of equal strength. They have shown likewise that a weak colony will sometimes gather more honey relatively than a strong colony. Certain it is that some bees are better workers than others, and it is usually the custom to breed from the queens that are the mothers of these good workers.

An attempt has been made to explain

the difference in morale between one colony and another. One colony may have the same numerical strength as another. The one that does poor work in the supers may have a large proportion of old and young bees and a comparatively small proportion of active field workers, or, as Latham calls them, "control bees."

Again, the colony that excels may have a very large proportion of field bees and a comparatively small number of young bees and really old bees. The inference is that the active bees in the prime of their lives are the ones that do the real work in getting together a good yield of honey. Colony morale may depend upon a difference in the strain of bees, or it may depend upon the right proportion of actual field workers to the rest of the bees. Probably both factors have a bearing on morale.

Control Bees

It is well known that there is no queen bee, much less a king bee, that controls the policies and destinies of a colony. The workers themselves seem to be the ones that direct or boss not only the queen herself, but the actual work of the colony. Latham, in an article in Gleanings in Bee Culture for January, 1927, and July of the same year, calls attention to what he calls the "control bees of the colony." "These bees," he says, "are not made up of the very young or the very old. They are probably between the ages of 14 and 21 days, and are in the height of their prime."

It is well known that successful armies are not made up of boys or of men past middle life, but men of an age at which they can do their best work, and at such age, too, that they can endure the maximum of hardships. The same principle is usually true in the hive. These "control bees," says Latham, "are the ones that decide when the swarm shall issue. They are the ones that go to the fields for nectar; defend the entrance, and, when necessary, start the offense. They are the stingers."

When a swarm leaves the parent colony it is important that it should have bees in the prime of their lives. Very young bees can not fly. Some that are somewhat older have not yet reached the age for field work, and they are yet at home. Very old bees whose wings are worn or frayed out would not be able to do effective work in starting a new home. Latham therefore thinks that the "control bees," as he prefers to call them, are the ones that usually leave.

Formerly it was supposed that all the young bees were left at home when a swarm issued and all the old bees joined the swarm. While this is true to a large extent, yet on the basis of the survival of the fittest only the best and most active bees should join the swarm, and they are probably the ones that make up the swarm that leaves the parent colony. There must be in the new home bees to build comb, bees to feed the young, and bees to go to the field.

In the same way "control bees" will ball the queen when she fails; they will carry out the bees that are worn out and the young that are crippled or feeble; in fact, they will rule the whole colony. The young bees and the very old bees seem to accept it as a fact, according to Latham, that they are to do as they are told, and there is not wanting evidence to prove that he is right.

Colony Odor and Queen Odor

Every colony has its own odor. Strange bees of another colony can not enter another hive without being grabbed and stung to death. Drones or young bees, on the other hand, can enter another hive; but adult workers are usually regarded as robbers and are dealt with accordingly. Were it not for this colony odor, or colony scent, it would be possible for strange bees to enter a hive, rob it out, and ruin the colony. As a dog recognizes his master by his keen sense of smell, so the bees distinguish between one of their own colony and a stranger by this same and wonderful scent.

Besides the colony odor, there is what is known as the queen odor. Every queen carries her own odor, so that a strange queen coming into a hive will be immediately recognized. So far as the queens are concerned, beekeepers could wish that the bees could not make this distinction between their queens. It would be a great convenience to be able to take out one queen and put in another —a better one.

In the height of a honey flow, however, queens of two different colonies can often be exchanged without the loss of either. The bees are so intent upon gathering honey that a mere exchange

of queens does not apparently make any difference with them. Even after the honey flow a whole frame of brood with its queen can sometimes be exchanged for a whole frame of brood with its queen from another hive, provided that the exchange is made without disturbance.

The Resting Periods of Bees

When rid of her load, the worker may at once return to the field, but usually she loiters about the hive for a while—from a few minutes to half a day. So commonly do such bees crawl into a cell and go to sleep for a half-hour or so that it is reasonable to assume that such is the customary proceeding. By sleeping is meant as nearly a complete suspension of movement as possible. The customary pulsation of the abdomen nearly, if not quite, ceases, or is suspended for minutes at a time, and the occasional pulsation is very slow.

When the nap is over, the bee backs out, combs off her head just as if "scratching for a thought," and starts off in more or less of a hurry.

Presumably, all the bees of a colony do some of this sleeping, and drones and queen are not exceptions; but in the case of the latter two, the sleeping is not usually done in cells.

When bees are getting stolen sweets, a very different condition arises; a feverish excitement is noticeable in the returning workers, and it is not long before the whole colony is in a more or less disturbed state. Sleeping then is not in evidence. Why a load or several loads of *honey* should cause so marked a difference from several loads of *nectar* is unknown, and until we know more about the bee it is idle to speculate.

The Bee Sleep

There is another resting period quite different from that above described. If there is no honey flow on, making it necessary for the bees to evaporate the nectar, the ordinary colony at night will go into a quiescent state approximating sleep. In our lecture trips exhibiting live bees from the platform, as noted elsewhere, we have repeatedly observed that the bees at night are much more "dumpy" or "sleepy" than during the middle hours of the day. They seem to form in listless masses, and at night are not disposed to fly out to the footlights as they are in the daytime. They remain in quiescent clusters, either in a hat or in any other receptacle in which they may be placed, making little or no effort to fly.

However, if bees have been confined for any length of time during winter and are then released at night or any other time, they will fly out toward the light, dropping their feces all over everything.

As cool weather comes on, the colony draws up more and more, as the temperature drops, in a compact cluster. When the weather is very cold, a large force of bees will contract to a ball about the size of a three or four quart oval jar. When the weather warms up this cluster will expand enough to cover all the combs. The average novice is led to wonder how it is possible for so large a force of bees to get into such a small compact mass.

In very cold weather, when the temperature drops to 57° Fahrenheit or lower, the bees inside of the cluster will begin to exercise. (See Temperature.)

Play Flights

As indicated elsewhere under this head, bees not only have their periods of rest, of apparent sleep or quiescence, but they have their times of play, especially young bees. Their outdoor demonstrations in a merry flight in front of the entrance, within a radius of 25 or 30 feet, sometimes look almost like robbing, because there will be bees going in and coming out of the entrance. It is very easy to determine whether the bees are at play or are robbing, by waiting a few mintes. If the demonstration in front of the entrance stops within for or five muinutes, it may be safely concluded that there is no robbing, that the bees are only at play.

These play spells occur usually after a period of confinement when the weather has been rainy, cool, or cold for several days. A warm atmosphere with plenty of bright sunshine immediately following is favorable for these play spells. On the other hand, they are never seen if the sky is overcast or the atmosphere a little chilly.

Joy Dance

More than a century ago (1788) Ernst Spitzner observed that when a worker honeybee returned to the hive with a load of nectar it performed certain movements which are now known as the round dance or nectar dance. Since then many other observers have witnessed this dance, and it has recently been very fully de-

scribed and its purpose investigated by K. von Frisch. After the worker has entered the hive and disposed of her load of nectar she runs around in a circle on the comb with rapid short steps. The circle is so narrow that usually only a single cell is inside of it. Often she runs one or two complete circles without reversing the direction; but often the turns follow each other quickly, and she describes only one-half or one-third of a circle in each direction. The round dance usually lasts about one-quarter of a minute, but rarely it may continue a full minute, or even longer in one place. Frequently she performs the dance in three or more places on the same comb. Finally she runs down to the entrance and flies away again to the flowers.

The round dance, according to the many experiments of von Frisch, communicates to the other bees on the comb that nectar-yielding flowers have been discovered. According to the same observer when a new and abundant supply of pollen has been found the pollen-gatherers inform their comrades of its existence by a different dance known as the wag-tail dance, or pollen dance. The bee with its load of pollen crawls up on the honeycomb and begins in the midst of the other bees to turn around in a circle, but she does not describe a full circle, but nearly a half-circle. She then runs back to the point from which she started, and, turning to the other side, runs a second half-circle, making, with the first half-circle, a full circle. Thus she runs alternately a half-circle to the right and then to the left, going back each time along the diameter to the starting-point. While running back the shortest way the body vibrates horizontally, the movement of its posterior end being the greatest, whence the name wag-tail dance. It is estimated that the body wags from four to twelve times on each straight run. The bee then leaves the hive as in the round dance. See American Bee Journal, page 76, February, 1924.

The author has had extensive opportunities on lecturing trips to watch the bees in their "jôy" dances every day for four consecutive summers. While he has seen the two dances described by von Frisch, he has likewise seen several others. The waltz either for pollen or nectar is seldom uniform, but varies very greatly with individual bees, and even individual bees will vary their performance on the same comb in the same interval of time. Sometimes the circles are small and sometimes large; sometimes the bees rush like mad straight across the comb with and without the "wag-tail" or "round dance." Sometimes the movement of the abdomen is sidewise (wag-tail) and sometimes it is up and down. The "wag-tail" may be shown in a small semi-circular movement, or it may be shown in a wide curve clear across the comb. The bee in some cases acts as if it were crazy.

It seems to be generally agreed that the dance is for the purpose of attracting the attention of other bees which have not been in the field, but which will now go out for new pollen or nectar. The attention of the other bees, following the dances, indicates unquestionably that they are interested. Whether those interested bees go out immediately to the fields or do so subsequently is rather difficult to prove. The natural inference, however, is that other bees follow the dancers by going into the field, if not immediately, very soon after.

When the supply of pollen or nectar is close at hand the author has repeatedly observed bees coming back and showing the joy dance within six minutes from the time the hive was opened. This has been verified so many times on different days that there can be no doubt of the fact. When bees that have been shut in are released about nine or ten o'clock (as they were on the lecture trips), they will first mark the location, if it is a new one, then rush immediately to the nearest pollen or nectar. If the sources are close at hand, they will come back in six or seven minutes and dance. If they are farther away, the interval will of course be longer.

There seems to be some question whether the bees that follow the dancers go straight to the find or whether they wander around until they do locate it. The author inclines to the latter opinion. In a bad case of robbing, the bees that follow the dancers will wander all over the apiary; hunt over the ground, inspect buildings and objects of all sorts, and increase the circles of flight until the coveted sweets are located.

The Washboard Movement of Bees

After the general season is over and there is nothing for bees to do, a dozen

or so of bees may be seen in the act of scrubbing the entrance board much as a wash woman scrubs her clothes. If, after the movement the alighting board showed evidence of abrasion or scraping we might surmise that the purpose was to clean the board; but no such abrasion can be discovered.

This washboard or scrubbing act has been reported several times through the bee journals but no satisfactory reason has as yet been offered. To say that it is a form of exercise is hardly tenable.

Bees Working on One Source of Nectar or Pollen at a Time

One of the most interesting of all facts in bee culture is that a bee, when it goes to the field in quest of pollen or nectar, will not, as a general rule, visit more than one kind of tree or plant on that same trip. If it starts gathering nectar from white clover it will not on the same trip take nectar from sweet clover, basswood, or any other source. In the same way, if a bee is gathering pollen from dandelion it will not gather any other kind of pollen on that one trip. While there are exceptions* to this rule, its application is so nearly universal that it may be stated as a fact that a bee usually visits only one source on a trip, either for pollen or nectar.

The question may be asked at this point, *why the bee does this.* Why should it not on the same trip take a sip of basswood nectar, white clover nectar, sweet clover nectar, or from any honey source available? What harm could come from making a blend of the nectar that it carries back home? In the same way, why does the bee gather only one kind of pollen on the same trip? It is probable that the bee, for reasons of its own, visits only one species on a trip. Perhaps that particular bee prefers the pollen of some particular plant when it is available. When that plant is out of bloom, then it visits something else. If this is the case, then there must be a variety of tastes on the part of different bees, and these preferences vary according to the season and the individual.

The author has repeatedly seen one bee visit only sweet clover blossoms, and one bee in the same field visit only white clover blossoms. One is almost led to believe that there is an "understanding" between plant life and the bees that show this wonderful fidelity in selecting flowers. If, for example, the bee visited different species on the same trip, it could not bring about pollination very successfully, if at all. The fact that there is a mutual adaptation between the plant kingdom and the animal kingdom in this particular is somewhat significant. We are told by biologists that there could be no co-operation between the two kingdoms, that the bees show this constancy for reasons of their own. It is true, however, that certain plants take advantage of this peculiar constancy on the part of the bees. If the bee visited different flowers on the same trip, certain plants might become extinct.

The theologian who believes that there is a plan of creation perhaps would claim that this very relationship between the bees and the plants was the result of design or purpose. But here science will step in and say that there is no proof that this occurs.

Certain it is that a large number of flowers and plants would be adversely affected if the bees did not, as a rule, confine themselves to one particular species in their quest for pollen or nectar.

The Unloading of the Pollen

On their return to the hive with their loads of pollen the bees differ widely in their behavior. A part walk slowly over the combs, while a part, presumably the younger bees, appear greatly excited, shaking their bodies and moving their wings. A cell may be selected with little hesitation or many may be examined before one is found satisfactory to the bee. The pollen may be stored in an empty cell, or in one already partly filled with pollen, either of the same kind or of different kinds; but drone comb is seldom

*Sladen says: "It was formerly believed that a bee hardly ever visited more than one species of flower on the same journey, but careful observers have found that, under certain conditions, changing from one species to another is not rare, and this has been proved by the presence of variegated loads of pollen. Bumblebees are more inclined to change from one species of flower to another than honeybees. This is especially true in the case of the common European species Bombus terrestris, which is closely related to the Canadian species B. terricola. In a nest of B. terrestris that I kept under observation in July this year, 40 per cent of the workers returned home with variegated loads. In order to discover exactly how the pollen basket is loaded, I took sections of a number of the variegated loads collected by the workers in this nest. In one of the most interesting of these, no less than eight successive kinds of pollen were distinguishable."

used, although this occasionally happens. Pollen will not be placed in cells containing eggs or brood. If a queen is cramped for room she may lay on pollen, but this is unusual.

The way in which the bee unloads the masses of pollen has been fully described by Casteel. Grasping one edge of the cell with its fore legs, it arches its abdomen so that its apex rests on the opposite side of the cell. The hind legs hang down freely in the cell with the pollen masses about level with its edge. The planta (metatarsus) of the middle leg on each side is then raised and thrust downward between the pollen mass and the tibia so that the mass is shoved outward and falls into the cell. The middle legs are now rested on the edge of the cell. Casteel was unable to determine definitely whether the spurs were of any aid in dislodging the pollen, as asserted by Cheshire.

The bee usually departs without any further attention to the pollen masses, and another worker shortly afterward attends to the packing. Entering the cell headfirst, the bee breaks up the pellets of pollen, mashes them down on the bottom of the cell, and adds honey and perhaps other secretions which change the chemical constitution of the pollen.

Propolis, How Gathered and Used

Propolis is brought in on the pollen-baskets. When it is gathered fresh from the buds, it looks like a glistening bead in the pollen-baskets; but when it is gathered from old frames, hives, etc., the pellets are more irregular. Propolis is always packed while the bee is standing, while pollen, which is packed and carried in the same baskets, is adjusted while the bee is flying. This difference in the way of using the same limbs for different materials is very interesting.

Propolis is taken from the legs of the field bees and stuck into all sorts of places and is moved and reworked as suits the vagaries of the bees. Much of the propolis is spread with the tongue. Whether or not the bee varnishes the inside of brood-cells with propolis is unknown. Certainly they spend much time polishing the inside of such cells, going over and over the surface with their tongues; and, when they have finished, the cell walls shine as if varnished. This is not done to new combs used for honey only; but let such be once used for brood, then it gets its polishing before being used for anything else.

Comb-repairing and building seems to be a haphazard job, and the work of one bee is often at once undone by another. Propolis is used in the construction of new comb, sometimes as much as one-half to three-quarters of an ounce being added to a pound of wax. It adds to the strength of the comb and makes its fastening to the wood more secure.

How Bees Deposit Their Load of Nectar

The honey-laden bee on returning from the field is not in a hurry to get rid of her load, and it is not at all unusual for her to keep it for half an hour or more before depositing it, or she may pass it to another bee and then hike back to the field. If there is a rush of nectar she will pass it to a bee that is not a fielder. This is a beautiful case of co-operation. Or, if there is no rush of nectar she may walk aimlessly about or settle quietly down somewhere and seemingly forget the world, or she may, after an extended journey over the combs, select a cell for her load. She enters the cell with her back down and feet up. If the cell has no honey in it, she goes in until her mandibles touch the upper and rearmost angle. The mouth and mandibles are opened and a drop of nectar appears, welling up until it touches the cell wall. Slowly the bee turns her head from side to side, spreading the nectar against the upper part of the cell. All this time the mandibles are kept in motion; and as the nectar covers their gland openings, it is possible that the secretion of those glands is being added to the nectar.

When the bee is adding her load to honey already in a cell, the proceeding is the same, except that the mouth parts are submerged in the honey already there. The mandibles are kept in motion as before. The tongue in neither case takes any part in the proceeding, but is kept folded behind the head.

How Bees Ripen Honey

The process by which the bees evaporate and gradually convert the thin nectar into thick honey is called ripening.

Honey-ripening is a slow but interesting process. After a day's work is about over, almost the whole colony spreads out over all available surface, and nearly every bee has her sac full of honey. All the bees hang vertically with head up,

and all seem to prefer not to be crowded too closely by the other bees. Then each bee opens her mandibles and mouth and forces up a drop of nectar. This drop fills the mouth and extends up over the upper lip and fills the space between the mandibles, covering the openings of the glands connected therewith. The tongue meantime is kept folded behind the head. Next, the bee begins a chewing motion, and this causes the drop to pulsate. The mandibles are held still. They are not moved as in depositing nectar.

For about ten minutes this operation is continued; then the drop is swallowed, and after a few moments' pause another drop appears, and the process is renewed. This is continued by the colony until about 11 p. m., or sometimes later, and then work stops and all hands go to sleep.

How the Bees Make Honey

When bees gather nectar it is largely water. Thin nectar stored in the combs with this excess of water would ferment and sour, and hence the bees drive out the excess of moisture until there is not more than twenty per cent of actual water to actual sweet in honey.

How, then, do the bees drive out this moisture? A. I. Root, in the early editions of this work, explained that some of the excess water is expelled in some way while the bees are on the wing. When the bees loaded up with thin nectar he actually saw them discharge a thin spray in the air. Others have seen it. He held that this spray is only water. How this separation is effected so quickly is not known. But not all of the excess of water is discharged while on the wing. When the load of nectar is stored in the cells there is still a large amount of water, probably three parts of water to one of actual sweet. During the day, and especially at night, the bees will form into two groups, one group forcing the air out of the hive and the other group forcing the air into the hive. There seems to be perfect co-operation, so that a strong circulation of air passes through the hive. This air forced in and out of the hive all night and during the day causes the freshly gathered nectar to evaporate so that there is not more than twenty per cent of water in the honey.

It is a very interesting experiment that any beginner can try out for his own satisfaction. After the bees have worked hard all day in the fields and made a gain of five or ten pounds of nectar, which is little better than sweetened water, the entire force goes to work ventilating the hive. By listening one can hear a low hum. There will be found bees on one side of the entrance that are fanning the fresh air in and bees on the other side of the entrance that are fanning the moisture-laden air out of the hive. By holding a lighted match first on one side of the entrance and then on the other, it will be observed that there is a strong current of air going in and an equally strong current of moisture-laden air coming out on the opposite side. This, kept up, finally reduces the water down to twenty per cent or less in the finished product, honey.

While the work is in process, the heavy hum so pleasant to the ears of beekeepers is continuous; but after the work ceases, the hive becomes almost silent. This varies with the amount of honey gathered during the day. Sometimes the humming lasts almost all night, and sometimes it ceases early in the evening.

Comb-building and Its Relation to the Ripening of Honey

Comb-building is rapid when most of the bees are ripening nectar. If the flow is good and many bees have to retain their loads for a while, as with a recently hived swarm, wax secretion is rapid. Or if the flow is heavy and nearly all have to work at the ripening process, wax secretion is forced. The bees can not help producing it then. Its production seems to be closely connected with the conversion of nectar into honey. If this view is correct, it affords an explanation of the failure to obtain satisfactory results in feeding back ripe honey to have sections completed. Honey extracted "raw" or "green" (that is before it is sufficiently ripened) and fed to comb-building colonies gives much better results.

Variation in Comb-building

No satisfactory explanation has been found to account for the construction of the two sizes of cells. Several theories have been advanced, but so far are only interesting.

Great variations in comb work are found between bees of different strains or of different colonies closely related.

Some colonies build comb of wonderful smoothness and uniformity, and others never produce good combs. One will rarely use brace or burr combs—that is, combs built irregularly on sides of hives or combs—while another sticks them everywhere. By selection the beekeeper can weed out the stock with undesirable traits and perpetuate the others.

The difference in capping is well recognized, and selection is as necessary in this case as in the former. The difference between colonies in building out to frame or section sides and down to bottom-bars or of rounding off the edges has often been remarked. It may be stated in a general way that the bees which build clear to the wood usually leave the outer cells unsealed, while those bees which round off the edges of the combs seal all cells. (This was first defined by Allen Latham.) Of course, there are all gradations, but fundamentally the law holds good.

The Arrangement of Brood, Pollen, and Honey

The arrangement of brood, pollen, and honey, the first in the center, the others about it in the order named, is interesting, and with rare exceptions this is always the arrangement. As the brood increases in the spring, we may say the pollen is forced outward and the honey forced beyond that. In the closing of the season the process is reversed, and under what we may be permitted to call natural conditions, as in a tree, box, or undisturbed frame hive, the brood is slowly worked downward and forward, so that at the end of the season the cluster is down by the entrance with the stores at each side of it and behind it. This is not always the location of the cluster in our frame hives; but if man has not meddled after midsummer, it will generally be found to be so.

The Color Sense of Bees

That bees can detect colors as well as odors, is now pretty well established. When hives are placed in straight rows and entrances are pointed in the same direction, the incoming bees often get confused and go into the wrong entrances. (See Apiary.) This can be corrected by painting the hive fronts different colors. Now for the proof. If a hive with a red front is exchanged with one having a blue front the bees belonging to the blue will go to the blue, and the bees belonging to the red will go to the red, notwithstanding the position of the two hives have been reversed.

In the same way, Dr. Karl von Frisch, of Germany, placed on a table variously colored cards, on one of which, the blue one, he placed a small dish of syrup. After the bees got nicely started on the syrup he rearranged the cards, but this time he placed an empty dish on the blue card remote from the position it formerly occupied. The bees first of all located the blue card and then clustered on the empty dish, but reluctantly departed. The experiment was repeated with the same result.

Nature has endowed some nectarless flowers with bright colors, the evident purpose being to attract insects.

When sweetness and color are both present in the same blossom, that species must require the visitation of bees or insects. We have a fine example of this in the apple trees. Here we have nectar, color and odor. (See Fruit Blossoms and Pollination, also Gleanings in Bee Culture, page 219, for 1930.)

Bees Are Red-Blind

Professor von Frisch has also trained bees to other colors—orange, yellow, green, violet and purple; but bees trained to red seemed confused when confronted with other dark shades. The bee eye can not segregate red from other dark colors. This is particularly interesting because it enables us to understand why red flowers are so rare. Botanically speaking, red is of comparatively frequent occurrence in America, but only in bird blossoms—the bird eye is very sensitive to red. In Europe, red-flowered plants are fertilized almost exclusively by butterflies, the only insects which are not red-blind.

Time Sense in Honeybees

Some work has been done by Dr. Ingeborg Beling, a student of Dr. von Frisch, which goes to show that bees have a time sense. Various feeding experiments were undertaken, showing that bees would come for food at certain intervals when it was set out; would retire and then return when the food was out again.

It is well known that certain plants yield nectar at certain intervals. Buckwheat, for example, will furnish honey in the morning and again at night when the atmosphere is cooler. (See Buckwheat.)

Bees will rush to the buckwheat nights and mornings when they will be absent during the middle hours of the day.

A fuller discussion of this time sense will be found on page 710 of Gleanings in Bee Culture, for November, 1929.

Homing Instinct

As the old saying goes, "chickens will come home to roost at night." While they may stray all over the premises during the day, they will toward night gradually work toward their coop and finally go to the roost. But chickens carried miles away from their home surroundings and placed down anywhere will find a place to roost and thereafter roost in the same place.

Similarly this same homing instinct is found in bees. The bees of a colony moved from their old location to a new place will, on their first flight, mark the location. As the bees fly out they will apparently take a survey of all the surroundings adjoining their home. The circles become larger and larger until they are lost to sight. They will in a few minutes return, however, unerring, to the entrance whence they came. There is no marking of the location thereafter except by young bees that go out for their first flight, and then their behavior is very much the same.

If the hive be moved a few feet only, the bees that have so thoroughly and so carefully marked the location will fly to the old spot. While this is true of Italian bees, the ordinary black bees, no matter where the hive may be placed, will relocate their hive, apparently doing so through their sense of smell. In this respect the black race and the yellow race behave very differently.

On his lecture tours for several seasons with the Redpath Chautauquas the author carried two nucleus hives of bees. The bees on arrival at the lecture town would be immediately released at a point just outside the tent. The same bees would mark their new location every day they were moved for seventy-two consecutive days. The average distance of one lecture town from the next was about seventy-five miles. Moving every day seemed to make no difference, because the bees would invariably mark the new location on arrival at the big Chautauqua tent. Sometimes members of the crew, not realizing the result of doing so, would move the hive a few feet away. In such a case the bees would come back to the spot where they were first placed, utterly disregarding the new location, because they were pure Italians. Had they been blacks, they would undoubtedly have flown around until they found where the boys had placed their cage.

Under Moving Bees and under the head of Uniting, further facts will be presented upon this "homing instinct." At this place, however, it may be stated that, if a nucleus or a weak colony is united with another colony elsewhere in the *same bee-yard*, all the old flying bees, on account of this same homing instinct, will go back to the old location, clustering on the ground. Even the blacks will go back; but, finding the old hive gone, they would hunt around through the bee-yard until they found their old hive. Yellow bees, especially Italians, would form a cluster on the spot where the old hive stood and starve to death, unless there were some hive very near where the old one stood, in which case they would enter that hive; but that hive would have to be within a few inches of the old hive.

Survival of the Fittest

In our modern factories today there is a tendency to drop out the old men—men who have held their jobs, doing the one thing all their lives. These men do not know any other work, and if they have not saved enough to take care of themselves in their old age they are obliged to beg or make a trip "over the hills to the poorhouse." The bees for ages have been pursuing this relentless policy of dropping out the old bees. When an old bee has toiled, worked almost the entire season, contributing its mite to the wealth of the colony, its wings become so frayed and worn that it can not fly any more. The younger members of the colony are not at all grateful to this old bee for helping to fill up the hive with honey they will eat. They seem to take particular delight in picking up these old chaps and dragging them to the entrance where they die of starvation, or carrying them up into the air and dropping them a half mile away. They can not fly back and they can not walk back; they die.

Similarly any young bees that are "born" with defective wings or legs, or any other bees that are not perfect in

every particular, are pushed out and allowed to die in front of the entrance. But as some of these bees will crawl back again, the able-bodied control bees will carry these defective bees out into the air and drop them a half-mile away, and of course they perish like the old bees.

The law of the survival of the fittest works all through the beehive, even including the queen bee. When she fails to lay eggs in sufficient number to take care of the needs of a prosperous colony, she, too, must step aside. It would be foolish to carry her out and drop her half a mile away. This would be worse than "killing the goose that lays the golden egg." So the bees allow her to keep on laying eggs, but in the meantime they start queen-cells, from one of which a new queen will be forthcoming. As soon as she begins to lay the old mother steps aside. Perhaps her daughter kills her. Perhaps the worker bees sting her to death and carry her out, or perhaps she may be allowed to lay eggs alongside of the young queen; but when she can not lay another egg, when she can be of no further use to that colony, out she goes. "If you can not work or will not work, you shall not eat," is the inexorable law of the hive. To allow these old bees, the crippled bees, the defective queens to remain in the hive might result in the loss of the whole colony, so nature or whatever you may call the ruling power in the hive, decides that only the fittest shall be allowed to survive and all else shall die.

That same principle is being carried out in the great human factories. The old workers are being ruthlessly pushed aside. The heads of these great factories take the position that they can not "compete in the open market" with their product if they keep these old inefficient fellows at their old jobs; that their first duty is to their stockholders, who will loose their dividends, if the old and inefficient are kept at work.

In the beehive the old bees would be consumers and die anyway before spring. Nature decrees that they shall die when their period of usefulness is over, and thus make room for young bees that will survive the winter.

Why Bees Sting

Under the head of A B C of Beekeeping, beginning with bees, and particularly under the head of Stings, some general principles are set forth showing under what conditions bees will sting, and why. Under this general heading a statement should be made explaining the cause more fully than is given elsewhere.

The sting of the honeybee is undoubtedly provided by nature as a means of offense and defense. Without some weapon of this sort their precious treasure, of which both man and beast are fond, would be taken, the colony itself ruined, and in the end the bees would become extinct. In a general way it may be stated that bees sting from one of two causes: (1) to protect their home; (2) because something has gone wrong. Bees are temperamental, having their good and bad days the same as their human owners.

Let us take up cause No. 1. No colony can be opened or examined by breaking into the hive in a ruthless or rough manner, even when all other conditions are favorable. A violent breaking into the hive leads the bees to believe that the intruder is trying to destroy their home and take away their honey. But if the hive be opened very gently, even without smoke (and this can be done oftentimes in the middle hours of the day when the air is warm), the bees may not sting. The reason for this is that there is no apparent invasion of their hives; no jamming or crushing to indicate that some powerful enemy is trying to destroy and rob their homes. There appears to be no objection on the part of the bees to having their combs taken out of the hive and placed all around, if the air is warm and there is no disturbance or rough or quick movements.

By the judicious use of smoke, however, one is able to break up the colony spirit or break up the normal activites in such a way that the bees are frightened and fill up with honey. Smoke is an irritant, entering into ten of their little breathing mouths or breathing pores. (See Anatomy of Bees elsewhere.) This so disturbs and so distracts them for the time being that the instinct of protection in the form of assault is obscured or forgotten. The whole attitude of the bees, in fact, is to get away from the disturbing smoke, and that thought is so prominent that they have no desire to use their natural weapon, the sting. It is this fact which makes

it possible for the beekeeper to take away the honey, to shake or jar the bees, with comparatively few stings.

Again, smoke causes the bees to fill up with honey. Well-fed bees, like a well-fed man or beast, are better-natured than those hungry or starving. It follows that smoke has a two-fold object.

The self-protecting instinct may be broken up or obscured by continued light, sharp blows upon the hive. Such pounding will cause the bees to fill with honey and later start the bees to running in fright. This is shown under the head of Transferring, and likewise under the head of Bee-hunting. In the case of a bee-tree the continuous chopping with the ax, if it is near the colony itself, will finally induce the bees to act like flies. Immediately after the first blow or the first few blows, the bees will fly out and sting; but a continuation of blows will finally demoralize the whole colony so that the log can be chopped open, the honey taken out, and yet not a bee will offer to attack.

The protective instinct to sting may be aggravated by adverse conditions. If the weather is cold or chilly, the whole colony is at home and in a perfectly normal condition. If the hive be opened without the liberal use of smoke at such times there will be plenty of fighting bees that will sting the owner unmercifully. On the other hand, if the weather is warm so that the bees can fly, most of the old or control bees will be in the field. The colony will be in charge of nurse bees or young bees. A reduction of the force, together with the fact that the young bees are easier to handle than old ones, puts the colony in much better condition to handle. In this case the protective spirit is submerged, because the older fighting bees are out foraging, and because the force is reduced.

A strong colony is always harder to handle than the same bees in the form of a nucleus. For this reason a beginner will find a weak colony easier to commence on.

Now let us take up the other cause (No. 2) that makes bees cross. That may be covered under the general word "disappointment"—something gone wrong. And from this cause it may be said that bees will often sting more viciously than from the first cause.

Bees are a good deal like their human owners. When everything is going right, when they are well fed, weather conditions favorable, honey coming in, and "business prosperous," they will be good natured, if they ever are; but the moment when things go wrong, the honey flow stops, weather conditions are unfavorable, atmosphere chilly and cold, then they are inclined to be cross.

In order to illustrate, it will be necessary to take a few cases. If there is a fine flow of nectar on, and a sudden shower or cold spell shuts it off, bees that were good natured before will be inclined to sting afterwards. The heavier the honey flow and the more suddenly it is shut off, the more vicious they will become. During a fine basswood flow when the yield is heavy and bees come dropping into the entrance so heavily loaded that they can hardly reach the hive, all is serene. But let there come a heavy rain, washing the nectar out of the blossoms, or a cold spell so that the nectar does not flow, that which was serene before now becomes the very opposite. While it was possible to open the hive when the bees were dropping down, it may be imposible to do much with them after the flow stops; and not until some time after their wrath cools off will they be tractable.

Again, by turning to Buckwheat it will be seen that the flow will usually be heavy in the morning, but ceases almost entirely in the middle hours of the day. By turning to Honeydew it will be noted that, when the saccharin matter is moist or sticky by reason of the dew in the morning, bees begin working on it freely; but when the midday sun dries it up there is nothing that bees can get. Either with the buckwheat or the honeydew the bees will be very cross after the flow of sweet has been shut off. The author has seen colonies of bees so vicious when working on honeydew that it was almost impossible to do anything with them.

It is generally a recognized fact that bees are crosser during a buckwheat flow than during a yield from clover. The former shuts off suddenly or almost suddenly. The latter continues to yield all day and again the next day. Unlike basswood, clover will gradually taper off, with the result that the bees scarcely notice that business is not prospering as well as it

did. Basswood may shut off suddenly—then look out.

By turning to Robbing it will be seen that bees will perhaps be more vicious after their supply of sweet has been shut off than at any other time during the entire season. Let the bees get to robbing freely in the honey-house, on good honey, especially basswood. While they are doing a land-office business, all is lovely. Now shut the honey-house door and see what happens. They will sting everybody and everything in sight.

Bees are always crosser after a rain, because it usually turns cold. The little nectar or pollen that they were able to gather before kept them in good humor; but the cool weather, together with the fact that the bee-glue is inclined to snap in the handling of the frames, will cause the bees to sting sometimes quite viciously, while the day before, when all was going well, they were good natured.

When bees rob out a colony of all its stores, the supply of honey gradually diminishing until all is gone, there is not apt to be a commotion; but if the beekeeper takes a hive that has been robbed before the supply is gone, carries hive and all down cellar, he should be on his guard. Those same robbers, finding that the hive is gone, will pounce on every other hive, and what is more, sting man, beast, and every creeping thing within sight. It is apparent that the theory of disappointment—something gone wrong—is a powerful factor in determining the temper of the bees.

There is still one more cause that could scarcely be classed under either No. 1 or No. 2, and that is interruption or interference in the smooth run of the work of the bees. To illustrate: If one stands in front of a hive where the bees in the height of a good flow of nectar are going in heavily loaded, and then going out, he will probably be stung. Any man or beast that is standing or walking in the line of flight of bees across a field is liable to be stung also. This is why farmers will sometimes complain that their horses are stung while cultivating or plowing. They are in the way. "Get out of the way or take the consequences," seems to be the attitude of the bees. They assume that they have the right of way.

These cases are cited to show that bees are exceedingly temperamental. When all is going well they are usually easy to handle; but when something has gone wrong, and especially if that something takes place suddenly, then the beginner beekeeper especially finds that his bees have suddenly gone on the warpath, and he does not know why.

The intelligent beekeeper, if he knows the causes that make bees good-natured and again cross, will be able to so time his work that he will let his "pets" alone when they would be anything but "pets" if he should attempt to handle them. (See Anger of Bees.)

Robbing

Under the head of Robbing and under the head of Stings it would seem that bees, much like human beings, like to get rich quick. Like their human owners, if they see a prospect by which they can gather large quantities of honey in a short time, they become almost crazy. They lose their heads, and, like their human owners, when they once get that "get-rich-quick" notion it is almost impossible to get it out. The gambler among men is inspired by the idea of getting rich quick, and, as the old saying goes, "once a gambler, always a gambler." In the case of bees, it has been found best to destroy these hardened old sinners rather than to allow them to annoy other bees and get a beekeeper in bad with the neighbors. (See under general head Bee Behavior, Why Bees Sting. See also Robbing and Stings elsewhere in this work.)

The Queen

This individual is unquestionably the most interesting member of the bee community, and more talked of and written about than any other, and perhaps more misunderstood. From earliest infancy she is subject to more vagaries than any of the other bees.

The presence or absence of the functional odor may have something to do with the introduction of alien queens, or it may be wholly their behavior.

After handling a laying queen, bees from any hive will run over one's hand, apparently eagerly seeking the queen, and the behavior of all workers is the same whether they are from the queen's hive or from another.

There is much difference in the tem-

perament of queens. Some are very timid, and will run on the slightest disturbance, and, if handled or anointed with any foreign substance, seem to become really frantic. Such queens are very apt to be balled or killed by the bees. Other queens will passively submit to all sorts of treatment, and, as soon as let alone, will quietly resume their duties.

Virgin queens are almost always nervous or timid; and if put into a strange colony, large or small, very often, or perhaps it would be more accurate to say generally, run out and fly away, by no means always returning.

Before mating, a queen hunts up her own food from the combs; but after she begins to lay she turns to the workers for virtually all her food. Occasionally she will dip her tongue into a cell of honey, but not often. As she passes about her duties, she from time to time crosses antennae with workers. Finally one is found with a supply of food; the worker's mouth opens and the queen inserts her tongue and begins to eat. The worker's tongue is kept folded behind the head. It is quite common to see several other workers extend their tongues and try to get a taste of the food, and sometimes one will succeed in putting her tongue in with the queen's. It is not at all unusual to see two workers getting food thus from another worker, and the drones obtain their food in the same way.

Egg production is influenced by several factors. Queens differ in fecundity, and egg development is dependent on food. The food supply comes chiefly from the younger bees; and, if they are not numerous, the queen can not produce eggs in abundance. If honey and pollen are scarce or temperature is low, food is not prepared freely.

If the queen is young and vigorous and the colony small, she may deposit several eggs in each cell. If comb surface is insufficient and bees abundant, she will use cells of any shape, deep, shallow, or crooked, and will put in each one an egg which will produce a worker. If no drone cells are available, a normal queen may at times put into worker cells eggs which will produce drones.

So many are the vagaries of a queen that only by observation and experience can most of them be learned, and the seasoned veteran not infrequently runs across some new peculiarity.

A normal laying queen proceeds over the comb depositing drone eggs in drone cells and worker eggs in worker cells, apparently being able to lay either drone or worker eggs at will. After an egg is put in a cell a worker is pretty sure to pop in and inspect it, and it has been supposed that possibly they did something to it. Inspection of thousands of bees occupied in examining eggs has failed to find a single one that touches an egg in any way. Bees often take their nap in cells containing eggs or larvae.

During a heavy flow of nectar, the bees often deposit it in cells containing eggs, sometimes filling the cells half full. Such nectar is removed within a few hours, and the eggs hatch as usual.

Balling of Queens

As explained under Queens and Queen-rearing, bees, whenever they are dissatisfied with their queen for any cause, suddenly form around her in a mad ball, all trying to sting her or pull off her legs and wings. First a few bees start the attack, then hundreds of others join in it. The reason why she is not stung immediately is because so many bees are clinging around her that it is impossible for them to turn and deliver their stings. Sometimes the queen is stung to death;* but more often she is found dead when the ball is taken apart, either from fright or from suffocation, but without a sting.

Balling of queen is apt to take place immediately after a hive is opened, if it is done carelessly or bunglingly, or after a disturbance. The bees, apparently thinking something has gone wrong, blame the queen and proceed to attack her. Careful observers have repeatedly noted that, as soon as the hive is opened, the bees for some unaccountable reason sometimes ball their own mother, even though she has been doing good work—a mother that has been in the hive for six months or a year. Just why this sudden mania of attack occurs no one has been able to explain. Of course, if she is a strange queen they ball her because she does not belong there.

It is believed that one or two bees

* Some doubt this, but the author has repeatedly, after pulling a ball apart, found a sting in the dead queen.

start the rumpus by chasing after and attacking the queen. This develops into a sort of mob, because queen-balling and the mob spirit brought on by a single leader in the human family have many things in common. The mob in either case is neither intelligent nor reasoning. It seems to be bent upon destruction of life and property, no matter what the consequences, and even though they are the chief losers.

(For further particulars in regard to balling, see Queens and Queen-rearing.)

Bees Caressing the Queen

When everything goes well the bees of the colony, especially the young bees, can often be seen standing around the queen in a circle extending their tongues ready to feed her, and all of them ready to clean her. They not only caress her, but comb her hair, give her a bath and remove her feces. As she moves about in stately fashion, as all queen bees do, all of the bees seem to vie with one another in showing her attention. But apparently these kindly acts are not inspired by any feeling that the queen will reward them. When a politician in the human family becomes overly nice to a voter, it is known that he is expecting a vote or some favors in return. No such political snobbery exists in the beehive.

Queen Cramps

Queens sometimes will, either through bunglesome handling on the part of the apiarist or through fright, develop cramps. Her body will kink up in a small semicircle, she will drop down on the bottom-board of the hive and appear to be almost lifeless. The bees, on the other hand, will be kindly disposed toward her, standing around her ready to feed or clean her. The novice is apt to conclude that the queen is dead or almost dead. If he will close the hive and let her alone she will come out of her cramps, nine times out of ten, and be as lively as ever. Just what the cause of these cramps is no one seems to know. Apparently it is a sort of "crick in the back," a kink in the body in some way from which she seems to be entirely helpless. She seems to be breathing normally, because the abdomen expands and contracts and the antennae move, but there is no other movement.

One Queen to the Hive

Under normal conditions there can be only one queen in a hive at a time. Under abnormal conditions there may be mother and daughter, or there may be one or more young queens ready to emerge from cells just before the issuance of a swarm. After the swarm issues, unless the beekeeper takes a hand in the procedure, each emerging young queen may lead forth a second, third, or fourth swarm, none of which will be of any value when they start housekeeping.

Again, in the case of a queen that is failing the "control bees," referred to elsewhere under this heading, start raising cells. The first young queen that emerges may be allowed in the hive along with her mother. She may even go into the air, be mated, return, and lay eggs on the same comb with her mother. But these cases are the exception rather than the rule. If the bees do not take a hand in the matter, the queens may fight it out between themselves, with the result that the older queen will be destroyed. It is possibly true, although it has not been proven yet, that the bees themselves finally destroy their old mother, probably knowing that it is not wise to have two queens in the same hive. In any event, it appears that the survival-of-the-fittest rule finally works out.

A strange queen can not be put into a hive where there is already one reigning. The bees will ball the stranger and kill her, as described under Balling. If the two queens should meet on the same comb there would be a royal duel, ending in the killing of one. But probably before this can take place the bees, especially the "control bees," take a hand in the proceedings and kill the stranger. These same "control bees," if the mother is killed by accident or otherwise, will not take a strange queen. By turning to Queens, Queen-rearing, and Introducing, it will be seen that the new queen must be kept caged in the hive until she acquires the same odor as the colony.

Drones

Drones have many interesting habits, and are well worth closer study than they have yet received. They are much slower to mature after emergence from cells than the workers. They are very fond of warmth and may often in cool weather be found massed shoulder to shoulder in outlying sealed brood.

It seems to take a lot of preparation on the drone's part before he can take wing. Drones pay no attention to a vir-

gin queen among them in the hive, no matter what her age.

Swarming

Swarming apparently starts with a bee here and there. Such a bee suddenly begins to run a few steps one way, then a few another, then spins around and finally appears to work itself into a veritable frenzy. Other bees take it up and soon a rush is made, and is quite as apt to be from as toward the entrance. As soon, however, as part of the flood begins to emerge from the entrance the tide turns that way and the majority of the bees begin pouring from the hive by thousands until the air is filled with a great cloud of humming bees. Usually they cluster on the branch of a tree not far from their hive, waiting to make certain that the queen is with them before leaving for their new home, which generally has been chosen by the scouts sent out several days before the swarm issues. (See Swarming.)

The question of whether a queen leads out the swarm or the swarm leads her out has been under discussion for some years. It is probable that there is no invariable rule. The best beekeepers are inclined to believe that the queen follows the swarm. On the other hand, the author happened to be near a powerful colony and heard the sound of the queen notes, "zeep, zeep, zeep." These notes continued for a space of 10 or 15 seconds. Out came the queen, followed by an onrush of the bees. The queen in this case obviously started the whole proceeding. It was not long before there was a big swarm in the air. But other cases have occurred where the very reverse was true—the queen was the last one to leave. The author, notwithstanding the instance above recorded of the queen's leading the swarm, believes that the control bees start the performance. In that case the queen follows.

(For the behavior of bees during winter, see Temperature, sub-head, Temperature of the Cluster in Winter.)

BEEBREAD.—A term in common use, applied to pollen when stored in the combs. In olden times (and in parts of the South yet) bees were killed with sulphur to get the honey, more or less pollen being usually found mixed with the honey; it has something of a "bready" taste, and hence, probably, came its name. Since the advent of the extractor and section boxes, it is very rare to find pollen in the honey designed for table use. (See Pollen.)

BEE DRESS.—See Veils.

BEE-ESCAPES.—See Comb Honey, also Extracting.

BEGINNING WITH BEES.—Any one who proposes to keep bees either for pleasure or profit would do well to study the matter as far as he can before he buys a single hive or a single bee. Of course, there are times when a bargain lot is offered at a very low price, perhaps at auction or at a private sale. The bees

Buying a good-sized swarm from a near-by beekeeper is a good way to make a start. One is enough to begin with.

must be taken then or not at all. It sometimes occurs through death that the ownership of some bees is suddenly thrust upon some survivor of the family. In all such cases one should read at least a

small text-book; or better, purchase this work written to cover the needs of the beginner as well as the specialist. If possible, he should visit some beekeeper. He should at least acquire some fundamentals in regard to opening a beehive. Without at least a theoretical knowledge, his first attempts may lead to disaster, and worse than all, a disgust for the business. Bees can be handled without stings, providing one knows **when** and **how**. The **when** is just as important as the **how**. An expert beekeeper avoids handling bees in chilly or cold weather, immediately after a rain or during robbing season. As far as possible his manipulations are confined to the middle hours of the day when the atmosphere is warm and balmy outside. If the bees have not received attention until fall or until after the weather has turned cold, the beginner at least should defer all attempts to handle his bees until some warm Indian summer day that may come any time in the late fall in the northern states. An expert beekeeper can handle bees in any kind of weather, if necessary, but he knows it is far better for him to work them when they are good natured and all surroundings are right.

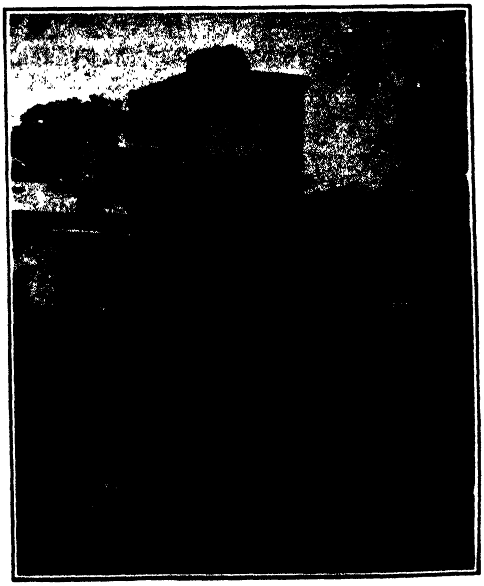
A beginner who is badly stung in his first attempts to do anything, not knowing the **when** and the **how** of handling bees, will give up the whole proposition and sell out cheap. Before a condition of this kind arrives, he should read A B C of Beekeeping and Manipulation of Colonies, particularly the sub-head, How to Avoid Being Stung. He should then read carefully Smoke and Smokers, Veils, and last but not least important, Bee Behavior. Under the last-named he will find some very interesting facts about bees that he should know before he endangers himself and his neighbors with an onslaught of stings.

How and Where to Buy Bees and Equipment

If one has come into possession of bees either through a bargain sale or through inheritance, he will, of course, not need to buy any bees or hives; but he should understand first of all that not all bargains are cheap at any price. If the bees themselves have been neglected before they came under the present ownership, the new owner must determine whether they are free from disease, such as American foulbrood. In most states of the Union there are foulbrood bee in-

The picture shows a row of hives, the colonies of which came from two-pound packages received from the South, and which, according to David Running, held their own against bees that wintered in the cellar under the most favorable conditions.

spectors. By writing to the State Capital, Department of Agriculture, one will learn who the state inspector is. Very



The colony occupying the five-story hive is one started from two pounds of bees received in the latter part of April, 1918, at David Running's home yard. These two-pound packages received by express from the South will often go ahead of the colonies wintered in the North.

often a letter addressed to the state bee inspector at the capital of the state will reach the proper party. A request should be made to have the bees inspected. The state bee inspector may have a record

Four-post cage for shipping bees.

of the bees. If so, he can inform the new or prospective owner whether they were at the last inspection free from infectious disease.

As a rule, the bee inspectors are willing to give instructions to beginners on how to handle bees, and the author, therefore, believes that the first thing to do is to get a bee inspector or one of his deputies to look over the bees before purchase is made. If no disease is found, he will be able to give some very helpful hints on how to prepare the bees, either for a honey crop, or, if late, for winter.

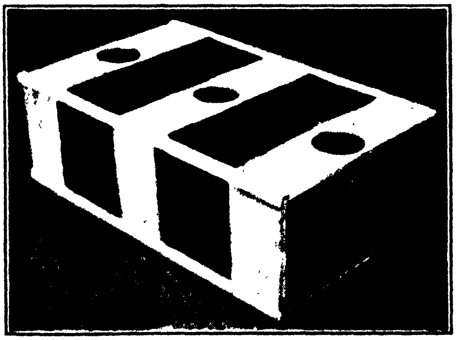
However desirable a job lot of bees may be, if they are located a hundred or more miles away, the cost of trucking expense or freight, plus the risk of possible bee disease, would make it much safer for the average beginner to buy new equipment in the form of hives, bee smokers, etc., and buy package bees of some well-known breeder whose bees are under the surveillance of the state and will be free from any possible infection. (See Package Bees.) By consulting the advertising columns of any bee journal one will be able to get a list of all those who are in position to furnish bees at reasonable rates. The publishers of this volume are also publishers of Gleanings in Bee Culture, which has a very large circulation. Sample copies will be sent free.

As the disease known as American foulbrood is frequently present in job-lot bees, beginners should buy swarms of bees in wire cages, or what, in trade circles, are generally called package bees. A nice little colony to start with, consisting of two or three pounds of bees with queen, can be shipped to the beginner by express at a nominal cost. Mr. Beginner should have on hand equipment for at least one or more hives furnished with frames containing full sheets of comb foundation (see Frames and Comb Foundation), a bee-smoker, and a bee-veil. The hives should be bought in the flat, and then put together, nailed and painted.

Bees will build up much more rapidly if housed in double-walled packed hives. (See Wintering Outdoors.)

Caution

Before buying bees let the beginner bear in mind the following: (1) Buy only of breeders who advertise from year to year and whose reputation is established; (2) do not be lured by very low prices; (3) specify that the bees must be young and that the queen, the most important



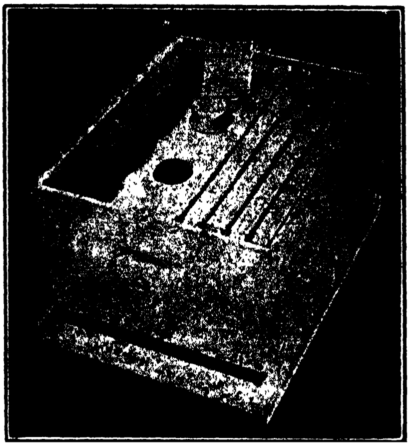
Note that the slats on which the bees cluster are in a horizontal position in respect to their width and that the ends of the cage are solid. The extra ventilation is provided by more wire cloth on the sides. This is a stronger construction than that shown in the opposite column.

personage in the bunch, be reared by modern methods, such as those given under Queen-rearing elsewhere; (4) specify date of delivery, and if shipper is a comparatively new man without a rating,

send part payment and place the balance in a local bank to be paid only when the bees are delivered according to contract; (5) unless one has advertised for years, and especially if he makes very low prices, ask for bank references; (6) order the bees as early in the spring as possible.

How to Release Packages of Bees

It will be assumed that notice has been received from the express office that the bees have arrived. If the weather is hot

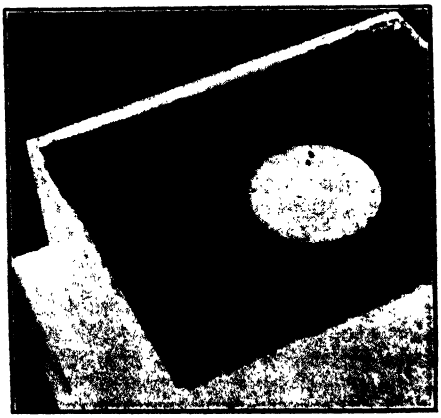


Illustrates how cage of bees is placed in hive at side of five frames.

or warm, the bees should be secured at once. If left out in a hot sun on the express platform, they may die within a few hours. Notify the express agent immediately to place the bees in the shade and where a breeze is circulating. As a rule, however, package bees should be ordered and received early in the spring when the weather will be cool, perhaps sometimes cold. Bees will ship very much better in the spring.

If many of the bees appear to be dead, or dying in the cages, it will be well to mix up a thin syrup, paint the outside of the cages, and place the bees in a cool place. Bees that are suffering for the want of water or food will take up the syrup on the wire cloth. Toward night, or a little before sundown, select the hive, or as many hives as there are packages of bees. Remove three or four frames of foundation from each hive, or just enough so that the cage of bees after the syrup can is removed or the cages opened can be set down in the space made vacant. Lift out the small cage containing the queen hanging down in the center of the cluster of bees to see that the bees are quiet, and slip it between two frames of foundation or combs. The queen should not be released at this time. The bees in the large cage will soon work over to where the queen is. If there is any syrup left in the can, let the bees have that. Whether there is any syrup or not, give the bees sugar syrup made of half water and half sugar, thoroughly dissolved. In order to accommodate the pan of syrup, it may be necessary to put a super on the upper part of the hive. Over the syrup should be placed a wet cheesecloth to prevent the bees from drowning. The bees will carry down some of the syrup and draw out some of the comb. In the meantime, if a piece of tin were nailed over the candy in one end of the queen cage holding the queen, this tin should be removed. Over night, or during the next day, the bees will eat away the candy and release the queen. If a little strip of pasteboard is placed over the candy, the bees will gnaw away this pasteboard. If the queen looks a little feeble, it may be well to release her at once.

The entrances of all hives containing package bees should be contracted down to a small space provided by the entrance stop or cleat. The purpose of this is to conserve the warmth and prevent any possible robbing because of the syrup placed in the new colony. There is a possibility

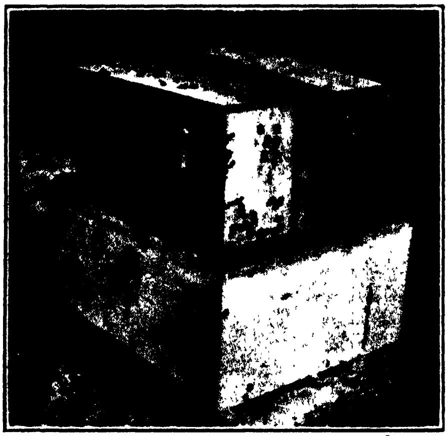


Sometimes pail of syrup is inverted directly over top of hives when hive does not have an inner cover.

that during the next day the bees will be inclined to swarm out, providing the queen was released. If the weather is very warm, it is advisable to leave the little piece of tin over the candy hole in the queen cage

and keep her confined for a couple of days. The bees will not swarm without the queen. At the end of that time they will have started to draw out the foundation, stored some of the syrup and started housekeeping. Next remove the tin, and the bees will shortly release the queen. In a few days she will begin to lay. Some think it advisable to put an entrance-guard or drone-trap over the entrance so that if the bees should attempt to swarm out the queen will be held. Of course the bees will soon return. (See Drone Excluding Entrance Guards under Drones.)

When we first began using packages we failed to secure satisfactory results, largely because we did not give the bees



When two packages are united to form one colony, the cages are inverted on top of the combs. An empty hive body is then set over them.

enough food. We have learned that we can not simply dump a package of bees into a hive containing frames with foundation or drawn combs, give the bees one 10-pound pail of syrup and expect them to build up to normal colony strength in seven or eight weeks.

As a rule, weather conditions during a part of the spring are unfavorable for nectar secretion and bee flight. We have found that it pays to feed each package at least two 10-pound pails of syrup and more if the bees will take it. In any event, there should be an abundance of food provided from the day the package is hived until the main honey flow starts.

We feed syrup (two parts sugar mixed with one part water, either by weight or measure) in a 10-pound friction top pail, inverted over a hole in the inner cover, the pail being protected with an empty super placed under the outer cover. The lid of the feeder pail has about a dozen holes made with a small three-penny nail.

When combs of honey and empty drawn combs are available we like to use four fairly well filled combs of honey for each hive, two on each side, and six empty drawn combs in the center. This makes an ideal arrangement. If some of the combs contain pollen, all the better. Bees require pollen for brood rearing and when there is a supply of pollen in the combs, brood rearing can proceed even if the weather is unfavorable for bees to fly.

The majority of beginners have to use frames with full sheets of foundation and sugar syrup for package bees. Success can be attained if the packages are installed early enough and if an ample amount of syrup is fed.

BEE-HUNTING.—Bee-hunting, like all other hunting of small game, or fishing with the rod, is a real pastime, and similarly not profitable from the standpoint of money-making. If one desires to get more bees, it will be far cheaper to buy them from a neighbor, or to order package bees from the South. (See Package Bees). It is sometimes necessary to hunt bee-trees that may possibly contain foul-brood. Before one can expect to get his apiary clean, all bees in trees should be located.

There is no use in making a general hunt for bees, except during a dearth of nectar, when the home bees are inclined to rob; neither is there any use in chasing after wild bees when the trees or caves where they are supposed to be located are more than a mile and a half away. While bees will sometimes fly farther than that distance from their homes in quest of nectar, these cases are rather rare. (See Flight of Bees.)

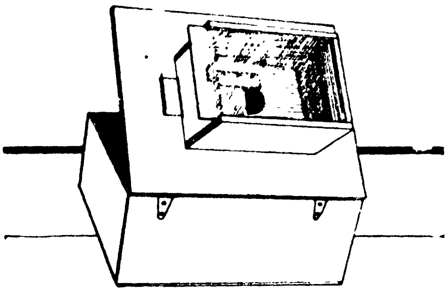
The possibility of locating a bee-tree is based on the principle that during a dearth of nectar bees may be attracted by sweets; once having filled up and after making a few circles they will fly in a direct line towards their home. But it should be understood that, while the general line is direct, that line is not straight as a bullet would fly, but somewhat irregular.

Equipment for Bee Hunting

This is neither elaborate nor expensive. While one can use a common tumbler and a square of cardboard to trap bees gather-

ing nectar, it is very much better to have a special box. This can be made from an ordinary cigar-box; but it should be well aired, as there might be an odor of tobacco, repellant to bees. Through the top should be made a circular hole about an inch in diameter. Over this should be placed a tin slide, so that the hole can be closed at will. On the cover of the cigar-box there should be mounted a smaller box without bottom and with a slide in the top that can be opened or closed. In the bottom of the cigar-box should be placed an empty comb or a small bee-feeder.

To attract bees it is better not to use a comb containing honey, because the honey would be too thick. The trapped bees will take about half a load of thick



Improved hunting-box used by Mell Pritchard, Medina, Ohio. The construction of the box is plainly shown in the illustration.

honey, with the result that their flight will be difficult and somewhat irregular, owing to air currents. For that reason it is best to take along a bottle of honey diluted with warm water. Honey is better than syrup, because it has more odor. It is likewise advisable sometimes to put into the honey water about two drops of anise to four ounces of syrup. The inside of the cigar-box itself may be coated with anise, so as to give the bees confined in the box more odor. The reasons for this will be apparent further on.

In addition to the box one should provide himself with a field glass, a pair of climbers such as the telephone men use, a rope, and an ax. The last named articles, however, are not necessary where one goes out alone and only expects to locate the bee-tree. Having found it, he will then need the ax, rope, and a pair of climbers, and some one to help him. One can not work alone to advantage.

If one suspects bee-trees in a piece of woods, he should make a little survey of the country, say a quarter of a mile distant. He should watch carefully for bees that are working upon some blossom. Old bee hunters say: "Avoid bees that are gathering pollen." Use only those that are apparently taking nectar and which show no pollen upon their body or upon their legs. Trap one of these bees in the cigar-box by shutting the lid, or inclose bee and blossom with the tin slide shoved over the hole. Hold that bee in the lower compartment long enough so that it will fill up with the honey water previously poured into the comb or the feeder. Place the box with its confined bee upon top of some fence-post, stump, or other object. If none of these are available, a stake with a small platform on top may be driven into the ground, and on top of this should be placed the box with its bee to be released. The operator should now pull back the tin slide, allowing the bee, now filled with honey water and well scented with anise, to go into the upper compartment. Gently draw back the glass slide and allow the bee to escape, then step backward quickly to watch the bee. It will circle around and around the box, taking a general survey, with the intention of coming back. The circles enlarge and become more elliptical until the long axis of the elliptical flights will point in the direction of its home. It will then strike off in a bee line, somewhat irregular, to its bee-tree.

An experienced bee-hunter writes that the bee will come back in a few minutes, the time gone being regulated by the distance. This same man, who has hunted bees as a pastime and a real sport, says that to make a round-trip flight it takes a bee about eight minutes for a half-mile and thirteen or fourteen minutes for a full mile. Other distances would be in proportion, of course. This allows for circling when a bee starts, the time in unloading without unnecessary delay, and the return flight. The usual custom is to start one bee at a time. Other bees can be trapped, fed, and released while the first bee is on its way to and from its hive. If all the bees take the same general direction as soon as they are released, the bee-hunter should mark some tree or other object on the horizon or in the woods that indicates the direction.

Sometimes it happens that there will

be three or four bee trees in the vicinity, with the result that there will be three or four directions. In that case one will have to decide on one of the directions. In the meantime the hunter will wait until the first bee has gone out and returned. The box should be opened and the glass slide should be drawn back so as to allow the returning bee to go down into the cigar-box. On the second or third trip the returning bee will in all probability bring back other bees. Watch the direction that these bees take, mark the line by some distant object as accurately as possible; note also the distance, according to the time that they have been gone. Every bee that is released should be carefully timed by watching. The average of the times will show approximately the distance.

After the bees are going and coming pretty rapidly one may move the box, or another one, on the same line, toward the distant place where the bee-tree is supposed to be located. It would be wise, perhaps, to move pretty well toward the woods, if they are a half mile away. Line the bees up as before, and this time take note of the object toward which the bees go. Again mark the spot, perhaps the other side of the woods, but in the same general direction. If the bees go back, then it is apparent that the bee-tree is somewhere between the two places whence observations were taken. The next move will be to establish a cross-line by putting the box over to one side some distance. The bees should be started in exactly the same way that they were started on the initial line. Where the two cross-lines meet, of course, will be somewhere near the spot where the bee-tree is located.

It is seldom worth while to look for bees in dead trees, because, this same bee-hunting authority says, bees will seldom establish a home in a dead tree. Apparently they know that they would be blown over or that the rains will soak into the rotten wood, even penetrating into the cavity where the bees are. With the opera glass, look over the immediate location indicated by the bee lines, watching especially for holes or hollows in the trees. Make a very careful search, and if it can not be located make still another cross-line, and where the three lines meet it is evident the bee-tree will be located.

Mention has been made that there might be other bee-trees, as shown by two, three, or four distinct lines from the original spot where the bees were lined up. One can now go back to the first position and take up one of the other lines, follow it out as already indicated for line No. 1 until the bee-tree is located. In the same way other lines can be traced. Of course, it is no use to waste any time in tracing lines that go in directions of well-known apiaries.

Getting the Bees Out of a Bee-tree

After having located the bee-tree it is the usual custom for one to mark his initials on the tree. Under common law the marking of these initials, if they are the first ones on the tree, gives the bee-hunter ownership of the bees, but not the legal right to cut down the tree or take the bees out of the tree without permission from the owner. Usually such permission can be obtained with little difficulty, especially if the owner of the tree is promised part of the honey that may be secured. In some cases it is unnecessary to cut down the tree. It is then that climbers and a rope are needed. If the bees are located in a hollow limb, this limb can be cut off with an ax or with a saw. There is no harm in allowing this limb to drop onto the ground. The very fall itself will so jar the bees that they will be very easy to handle afterwards. But one can not very well cut off a limb or chop into a tree if he is up in the air without blowing plenty of smoke into the entrance of the hollow limb to quiet the bees. A bee-smoker is always a necessity in bee-hunting. If the bees are located in a hollow in the body of a tree, about all one can do is to cut down the tree. As a rule, a hollow tree is of little value to the owner from the standpoint of lumber. After the tree has been cut one may then chop into the cavity where the bees are located and take out the honey and the bees. When the tree comes crashing down, the bees in the hollow will come rushing out. If one has a bee-veil and smoker, there need be but very little trouble. First use smoke. After a few blows on the tree with an ax, the bees will quiet down, when the smoker will not be needed thereafter.

If it is discovered that the bees are in some giant tree five or six feet in dia-

meter, and the owner will not allow the tree to be cut, the bees can be removed by driving twenty-penny spikes into the body of the tree at intervals of eight or ten inches. These spikes can be used somewhat as the rounds of a ladder until the opening in the tree is reached. Generally bees located in such enormous trees better be abandoned, if permission to cut can not be secured.

How to Get Bees Out of Bee-trees or from Between the Sidings of a House without Mutilating Either the Tree or the House.

A colony of bees will sometimes take its abode in some fine shade tree in a park, which the authorities will not allow to be cut; or it will domicile in the woods of some farmer, who, while he will allow the bee-hunter to get the bees, will not let him cut the tree; or it may make its home between the plaster and the clapboarding of a house. How, then, can such bees and their honey be secured without doing any damage to the tree or the building that gives them a home and protection? The matter is made very easy by the use of the modern bee-escape. (For particulars regarding this device, see Comb and Extracted Honey.)

After the bees are located in the bee-tree, the hunter prepares a small colony of bees or a nucleus with a queen-cell, putting it into a light hive or box, which can be carried to the scene of operations. He takes along with him a hammer, a saw, some nails, and lumber, with which he can make a temporary platform. On arriving on the spot he lights his smoker and then prepares to set up his platform directly opposite to or in front of the flight-hole of the bee-tree, or the knot-hole of the dwelling. The platform he constructs out of the lumber he has brought. Before doing so it will be necessary for him to blow smoke into the flight-hole in order to prevent bees from interfering with the building of the temporary hive-stand. He next puts a bee-escape over the flight-hole of the tree or building, in such a way that the bees can come out but not go back in. Last of all he places his hive with the bees which he has brought, with its entrance as near as possible to the bee-escape (now placed over the old entrance.)

His work is now complete, and he leaves the bees to work out their own salvation.

The bees from the tree or building, as fast as they come out, are, of course, unable to return. These, one by one, find their way into the hive on the temporary platform. At the end of four or five weeks the queen in the tree or dwelling will have very few bees left, and there will also be but little brood for that matter, through lack of bees to take care of it, for her subjects are nearly all in the hive on the outside.

At this time Mr. Bee-hunter appears on the scene. He loads his smoker with fuel (brimstone), removes the bee-escape and brimstones the old colony, or what is left, which by this time is probably not more than a handful of bees with the queen.

Again he leaves the scene of operation; but the bee-escape is not replaced. What happens now? The bees in the hive, including those that were captured, rob all the honey out of the old nest in the tree or house in the course of three or four days, carrying it into the hive on the extemporized platform.

The bee-hunter now takes away the hive, removes the temporary hive-stand and carries the bees home. If they be taken a mile or a mile and a half, they will stay where placed. If the distance is less, the colony should be moved to a temporary location two miles or more away and left a week before being taken home. The old entrance to the tree or building should be closed up or other bees will occupy the quarters. The old comb would attract scouts for a swarm to follow.

In the meantime, no damage has been done either to tree or building, as the case may be. All that will be left in the tree will be some old dry combs which, in the form of wax, probably would not amount to fifty cents, if the time of rendering be taken into account. Very shortly the bee moth will occupy the combs, consume them and leave a mass of web behind. (See Moth Miller.)

This method of taking bees could not very well be practiced where the bees are located in inaccessible positions, as in high trees; but it will be found very useful where a colony is located in some building or shade tree in a park.

The author is indebted for the general principles of this plan to Ralph Fisher, of Great Meadows, N. J., who has practiced this plan with success.

BEEKEEPING AND FARMING.—See Farmer-Beekeepers.

BEEKEEPING AND FRUIT-GROWING.—Under Fruit Blossoms and also under Pollen it has been shown that beekeeping is very intimately related to fruit-growing. The production of much of the fruit from many trees and shrubs is dependent on the pollen being carried by bees to the bloom from different individuals or varieties of the same species. In most cases the quantity is increased and the quality of the fruit is improved when bees are present. The two industries can, therefore, be united with great advantage. Intelligent fruit-growers have learned to appreciate the valuable work performed by bees. As they become convinced that the services of these little friends are indispensable, they not only begin buying colonies of bees, but gradually increase their number until it is not uncommon for a fruit-grower to own a large apiary. So far from adding to the expense of fruit culture, the surplus of honey obtained has proved that beekeeping may become a very profitable sideline to fruit culture. One man, or force of men, can care for the bees a part of the time, and for the fruit trees the other part, and thus be able to furnish two of the finest sweets in the world—the sugar in fruit and the sugar in the nectar of the flowers. (See Fruit Blossoms, also Pollination.)

BEEKEEPING AND POULTRY RAISING.—Under the head of Beekeeping and Fruit-growing it is shown how these two occupations go well together. If there is any industry, aside from that of growing fruit, that combines nicely with the keeping of bees, it is poultry. When the bees require the most attention, the poultry need the least. When chickens demand the most time, the bees are taking their long winter sleep, and, of course, require no attention, or very little. In the more northern states, at least, the bees are put into winter quarters in the fall, and require almost no attention until the following spring, along in April or May. During this time the chickens require considerable care. If one would have early broilers in the spring, he must order his baby chicks early or start his incubator going early. He must feed his chickens so that they will lay during the

Bees and chickens in the same back lot, Detroit, Mich.

winter. Incubator work and the brooding of chickens take place in the spring. The bees at that time require little attention in the way of feeding and going over to see whether any of them need uniting, provided they were properly cared for the previous fall. (See Food-chamber and Feeding for Winter.)

Bees will not require care until about the middle of May or the first of June in the northern states. In the South honey would come in much earlier and of course chickens would be able to take care of themselves that much earlier. Just about the time the bees begin to require considerable attention the hens will begin to lessen their laying, and the weather will be such that they will not require such careful feeding, for usually they can get a good deal of their green food directly from the ground. At that time the beekeeper will be either giving his colonies more room or extracting. If the chickens require much of his time he can simply put extra supers on his hives, piling them one on top of the other until he has the hives stacked up three or four stories high. If he practices swarm-prevention by the methods given under Swarming, Demareeing, and Artificial Swarming he will not have much trouble with swarms.

One can scarcely make a living from one or two hundred colonies; but that number in connection with poultry-keeping or the growing of fruit helps to make up the general income of the family. (For a further consideration of the question whether bees can be made the sole means of livelihood, see Profits in Bees, Back-lot Beekeeping, Specialty in Bees, and the Foreword.)

BEEKEEPING AND PREACHING THE GOSPEL.—If there is any class of people who need recreation out of doors, it is the clergy of both the Protestant and Catholic churches. For this purpose there is no better outdoor sport that will pay back in dollars and cents than beekeeping. The study of bees is a study of nature and, of course, that means God. It reveals as no other sport or pastime does the wonderful correlation and co-operation between the insect and plant world. It delves into the science of chemistry and dietetics. In the language of Dallas Lore Sharp, bee life "has not only developed a perfect political organization, but founded it upon an equally perfect society—division of labor, divorceless marriage, obedient children." In short, the study of bees will furnish to the pastor for his sermons a wealth of material and illustration that will fit well into the human hive. Some of the finest and best work ever done on bees was by a Catholic priest—Dr. John Dzierzon, of Germany. Dr. Dzierzon is known the world over for his discoveries of some of the wonderful secrets in the bee hive. (See Dzierzon.)

The Rev. Mr. Wilson, his church and his little apiary.

The Rev. William H. Wilson of the Baptist Church of Washington C. H., Ohio, has likewise made a success with his bees. In 1932, when the great depression was at its worst, his bees were no small factor in keeping his daughter in college. He started with six colonies, produced a surplus of over 1200 pounds of comb honey and made an increase of 17 colonies. This, on a basis of spring count, would make an average of 200 pounds of comb honey. In addition, says Mr. Wilson, he derived healthy enjoyment and some splendid material for his sermons.

The story of work, self-sacrifice and a devotion to the life of the colony carry lessons, he says, for the human hive or community. Last, but not least, he said when he visited the sick of his parish he often took a section of honey. The fact that it was of his own production made it mean more to his people.

Father M. G. Hepner, of St. Mary's College, North East, Pa., has made a great success with his bees. Not only that, but

Father Hepner demonstrating the gentleness of Caucasians in the rain. He pounded on the hive, ripped off the cover, and jerked out the frames without using smoke. No one was stung.

he is teaching his pupils how to keep them.

Many more stories might be told of the pastor and his bees. Beekeeping and preaching go well together.

BEEKEEPING AND SCHOOL TEACHING.—Beekeeping fits in exceptionally well with school teaching, for the bees need but little attention during the winter term of school. In the North, even when the school is continued until the first of June, the little attention needed can be given on Saturdays or nights and mornings.

At the close of the school year, beekeeping furnishes for the tired teacher pleasant outdoor recreation, often better fitting him for the next year's work than do other forms of vacation which yield no profit but consume much of his winter earnings.

Any school teacher who has come in contact with bees for a season or two will be very much better fitted to teach the sciences, especially those that relate to insects and plants. One can hardly have very much to do with the bees without learning something about pollination and something about the wonderful things in insect life. The study of bees is fascinating, and any teacher who knows something about the habits of bees, especially how they increase the fruit crop, will be able to give some very practical information to his pupils, even though they do not go any further with the bees themselves.

There are a large number of teachers, superintendents of schools, and college professors, who are making beekeeping a healthful and profitable sideline. The extra income from the sale of honey is oftentimes a material help in boosting a salary already too low. A trained mind will often enable one to succeed with bees where little more than brute force would meet with failure. A teacher who has ten or twelve weeks of vacation can often make that period very profitable, as experience in hundreds of cases has shown. One college professor operates over 1000 colonies and his income from his vacation work of three months is often greater than what he earns in nine months at teaching.

BEEKEEPING AND TRUCK GARDENING.—Beekeeping can be managed in connection with truck gardening, but they do not make nearly as good a combination as bees and poultry. The difficulty in combining bees with gardening is that the latter requires its greatest attention when the bees also need a large amount of care. There are times and circumstances, however, when beekeeping, fruit-growing, and poultry-keeping might all three be worked together; but in most cases probably the man who attempted this would be a "Jack of all trades and master of none."

BEEKEEPING AS A SPECIALTY.—See Beginning with Bees, Profits in Bees, and Specialty in Bees.

BEEKEEPING FOR WOMEN.

[It is presumed, of course, that no ordinary man would be competent to write on a subject of this kind. In looking about for some woman to do this, the author could think of no one more able than Mrs. Anna B. Comstock, author of a charming work for beginners on "How to Keep Bees." Mrs. Comstock is the wife of Prof. J. Henry Comstock, of Cornell University, and both of them are entomologists.]

Two questions invariably pop up at us

when this matter of feminine beekeeping is discussed: One is, "Why shouldn't a woman keep bees?" and the other is, "Why should a woman keep bees?" Like most other questions these may be answered more or less rationally with proper consideration.

Taking the "why shouldn't" question first, we are bound to confess that nowadays there is no effective reason why a woman should not do almost any thing that she takes into her enterprising little head to do. But quite aside from the consideration of woman's prowess, there are one or two reasons that might deter some of the faint-hearted fair from undertaking beekeeping. There is no use trying to gloss over the fact that there is a great deal of hard work and heavy lifting in the care of a profitable apiary. The hard work is really no objection, as most women of whatever class are doing it anyway. But lifting heavy hives is certainly not particularly good exercise for any woman, although I must confess that I have never lifted half so strenuously when caring for the bees as I used to on the farm when we moved the cook-stove into the summer kitchen, accomplishing this feat by our feminine selves, rather than to bring to the surface any of the latent profanity which seems to be engendered in the masculine bosom when taking part in this seasonal pastime.

There are at least two ways of obviating this feminine disability in beekeeping. One, practiced successfully by several women, is through the use of a light wheelbarrow, which almost solves the problem if the bees are wintered out of doors and do not have to be carried up and down cellar stairs; the other method is to get some man to do the lifting and carrying.* It may be the husband, the father, the brother, the son, or the hired man; but as this work can be done at a time which can be planned for, it is not so difficult for the men of the establishment to give the help needed. I am sure my husband would say that I am quite enthusiastically in favor of the man solution of this problem; but his opinion does not count for much, because he loves the bees so enthusiastically I have to beg for a chance to work with them at all, although he virtuously points out the hives to people as "Mrs. Comstock's bees."

Another "shouldn't" reason might be that women are afraid of bee-stings. This falls flat, from the fact that women are not a bit more nervous than men in this respect. One year when I was struggling to hive a swarm from a most difficult position, an interested man stood off at a safe distance in a most pained state of mind. He was a courteous gentleman, and he felt that it was outrageous for me to have to do the work alone, but he did not dare to come to my aid, and I think he considered my temerity in dealing with the swarm as almost scandalous.

Thus having disposed of all the reasons I can think of why women shouldn't keep bees, I turn gladly to the more interesting reasons why she should look upon the apiary as one of her legitimate fields of labor. There are so many reasons for this that I could not enumerate them even if a complete number of a bee journal were given me for the purpose. So I shall speak of just a few of the most important reasons. I should put first of all, and as embracing all other reasons, that beekeeping may be made an interesting avocation which can be carried on coincidentally with other employments; it is an interesting study in natural history; it cultivates calmness of spirit, self-control, and patience; it is a "heap" of fun; incidentally it may supply the home table with a real luxury; and it may add a very considerable amount to any woman's spending-money. It can also be carried on as a regular business, to support a family.

But it is as an avocation that I am especially interested in the apiary. Any woman who keeps house needs an avocation to take the mind and attention completely off her household cares at times. There is something about the daily routine of housekeeping that wears mind and body full of ruts, even in the case of those who love to do housework better than anything else. Talk about the servant question! It is not the servant question, but the housework question. If some means could be devised by which housework could be performed with inspiration, zeal, and enthusiasm, the servant problem would solve itself; but this ideal way of doing housework can be carried on only when the spirit is freed from the sense of eternal drudgery. I am not a wizard to bring about this change; but I know one step toward it, and that is the

* Some frail women remove all honey, one comb at a time.

establishment of some permanent interest for woman that will pull her out of the ruts and give her body and mind a complete change and rest. Embroidery, lace-making, weaving, painting, and several other like occupations, may serve this purpose in a measure; and, perhaps, if carried on in the right way, may achieve more in this line than they do at present. But these are all indoor occupations; and what a woman needs is something to take her outdoors where she can have fresh air. Excess of perspiration induced by the cook-stove is weakening; but honest sweat called forth in the open air by the application of generous sunshine is a source of health and strength.

Beekeeping is one of the best of these life-saving, nerve-healing avocations; it takes the mind from household cares as completely as would a trip to Europe, for one can not work with bees and think of anything else. Some of the attributes which make beekeeping an interesting avocation I will mention: First of all, bees are such wonderful creatures, and so far beyond our comprehension, that they have for us always the fascination of an unsolved problem. I never pass our hives without mentally asking, "Well, you dear little rascals, what will you do next?" Bees are of particular interest to every woman for several reasons; if she likes good housekeeping, then the bee is a model; if she likes a woman of business, again is the bee a shining light; if she is interested in the care of the young, then is the bee-nurse an example of perfection; if she believes in the political rights of women, she will find the highest feminine political wisdom in the consitution of the bee commune. In fact, it is only as a wife that the bee is a little too casual to pose as ideal, although as a widow she is certainly remarkable and perhaps even notorious.

Another phase which makes beekeeping a pleasing avocation for women is that much of the work is interesting and attractive. I never sit down to the "job" of folding sections and putting in starters without experiencing joy at the prettiness of the work. And if there is any higher artistic happiness than comes from cleaning up a section holding a pound of well-capped amber honey and putting the same in a dainty carton for market, then I have never experienced it; and the making of pictures has been one of my regular avocations. By the way, woman has never used her artistic talent rightly in this matter of cartons. Each woman beekeeper ought to make her own colored design for the cartons, thus securing something so individual and attractive as to catch at once the eye of the customer.

As a means of cultivating calmness, patience, and self-control the bee is a well-recognized factor. Bees can be, and often are, profoundly exasperating; and yet how worse than futile it is to evince that exasperation by word or movement! No creature reacts more quickly against irritation than the bee. She can not be kicked nor spanked; and if we smoke her too much, we ourselves are the losers. There is only one way to manage exasperation with bees—that is, to control it; and this makes the apiary a means of grace.

The money-making side of beekeeping is a very important phase in arousing and continuing the woman's interest in her work. I think woman is by birth and training a natural gambler, and the uncertainty of the nectar supply and of the honey market adds to rather than detracts from her interest in her apiary. I know of several women who have made comfortable incomes and supported their families by beekeeping; but, as yet, I think such instances are few. However, I believe there are a large number of women who have added a goodly sum yearly to their amount of spending money, and have found the work a joy instead of drudgery. Personally, I have had very little experience with the commercial side of beekeeping. Once when our maddeningly successful apiary grew to 40 hives when we did not want more than a dozen at most, and the neighborhood was surfeited with our bounty, we were "just naturally" obliged to sell honey. We enjoyed greatly getting the product ready for market, and were somehow surprised that so much fun could be turned into ready cash. As a matter of fact, both my husband and myself have absorbing vocations and avocations in plenty, so that our sole reason for keeping bees is because we love the little creatures, and find them so interesting that we would not feel that home was really home without them; the sight of our busy little co-workers adds daily to our psychic

income. We are so very busy that we have but very little time to spend with them, and have finally formulated our ideal for our own beekeeping, and that is to keep bees for honey and for "fun." We shall have plenty of honey for our own table, and just enough to bestow on neighbors so they will not get tired of it; and fun enough to season life with an out-of-door interest and the feeling that no summer day is likely to pass without a surprise.

BEE LEGISLATION.—See Laws Relating to Bees.

BEE MOTH.—See Moth Miller.

BEE PARALYSIS.—See Diseases of Bees.

BEE-SPACE.—This term is applied to spaces left by the bees both between combs they build and between the parts of the hive and the combs. It varies all the way from 3-16 to ⅜ inch; but 5-16 is considered the correct average. But in hive-construction it has been found that a space of ¼ inch will be more free from the building of bits of comb and the depositing of propolis than a little wider spacing. Any less space than 3-16 will be plugged up with propolis and wax. (See Frames.)

Father Langstroth, in the great invention which he gave to the world — the **first practical** movable frame—made the discovery that bees recognize and protect passageways which are now called bee-spaces. (See A B C of Beekeeping, also Hives.) Taking advantage of this fact he made a frame (for holding comb) so that there would be a bee-space all around between it and the hive, and a bee-space between it and any other frame. All who preceded him had failed to grasp the fact that bees would leave such spaces unfilled with wax or propolis. Before Langstroth's time it was necessary to pull out frames stuck fast to the hives with propolis, or tear or cut loose the combs with a thin-bladed knife, before they could be removed for the purpose of inspection.

By bringing out this bee-spaced frame the "father of modern apiculture" solved, with one great master stroke, a problem that had been puzzling the minds of beekeepers for centuries.

In later years, manufacturers of hives have been compelled to recognize this great principle, that there are certain parts inside of the hive that must be bee-spaced from every other part or else they will be stuck or glued together in a way that will make them practically inseparable. For example, the bottoms of supers containing the sections must be $\frac{5}{16}$ inch above the tops of the brood-frames in the lower part of the hive. It has come to be a general practice to put the bee-space in the bottom-board, leaving the bottoms of the frames in the brood-nest nearly flush with the bottom of the hive. This makes it necessary to have the sides and ends of the hive project above the general level of the frames about $\frac{5}{16}$ inch. In the same way the supers have a bee-space on top but not on the bottom. If a super be removed, and a hive-cover be put in its place, there will still be a space between the cover and the brood-frames.

There are a few who believe that the bee-space should always be under the frames or sections. This will necessarily require that the top of the hive or super be even with the tops of the frames or sections, and that the covers have cleats on the outside edges a bee-space thick. Such a combination is objectionable, because these cleats could not be made tight enough to keep out rain and cold, and because there are many beekeepers who like to use a flat board cover that may be used either side up. It is very much more satisfactory to have the bottom-board cleated in the manner stated than the cover. Even if the cleats are not tight, warm air would not escape at this point. Practicaly all the beekeeping world is united in favor of having a bee-space on top of the frames and sections rather than under, and probably 99 per cent of all the hives in use are so built. Any beginner or other person who will attempt to devise a hive with a bee-space on the bottom will be making a great mistake. His material will not match other equipment; and if the time comes when he will have to sell he would have to dispose of it at a considerable reduction in price, for the reason that the bees would have to be transferred into other hives that would fit appliances commonly in use.

A Deeper Space Over the Hive Bottom

It is customary to make a space between the bottoms of the frames and the bottom-board much greater than the space on top. Modern hives usually pro-

vide from $\frac{7}{8}$ to 1 inch of space under the frames to allow for plenty of ventilation during hot weather. Such a space should have an entrance $\frac{7}{8}$ inch deep. This is none too large during the hottest part of the year. (See Entrances to Hives.)

During the winter, whether in the cellar or outdoors, the extra space allows for an accumulation of dead bees under the frames. If the bee-space under the frames is only $\frac{5}{16}$ it might soon clog up with dead bees, thus preventing ventilation, finally ending in the destruction of the colony.

BEES.—See Races of Bees; also Italian Bees.

BEES AS A NUISANCE.—It would seem almost out of place to discuss this question in a work intended for study by those who believe (and rightly, too) that bees are not a nuisance; but, as will be shown, there are very good reasons why the matter should be calmly discussed in order to avoid trouble that may arise in the future. Certain difficulties have arisen between the keepers of bees and their neighbors. Perhaps the bees, after a long winter confinement, or after several days' confinement at any time, have taken a flight and soiled the washing hung on a line in a neighbor's yard. Possibly some of his children have been stung, or there have been times when he has been greatly annoyed while in the peaceable possession of his own property by bees coming on his premises and smelling around, as they sometimes do during the fruit-canning season when the aroma of sugar and juicy fruits escapes through the doors and windows of the kitchen. Possibly the offended neighbor keeps chickens, and members of his feathered tribe have trespassed on the grounds of the beekeeper. The result of all this is that bad feelings arise. Complaint is made to the village officers; an ordinance is proposed declaring bees within the limits of the corporation to be a nuisance and requiring the keeper to remove them at once or suffer the penalty of fine or imprisonment, or both. Fortunately the courts have held that the ordinances prohibiting the keeping of bees inside of a city or town are unconstitutional. (See Laws Relating to Bees.)

In some instances live stock has been stung; a cow or a calf or a horse may get near the entrances of the hives, which, possibly, are within a foot of a dividing line between the two properties. Perhaps the stock is stung nearly to death. Damage is claimed and a lawsuit follows, with the result that a feeling of resentment is stirred up against the beekeeper.

Or again, the beekeeper may have an apiary in his front yard, bordering on the common highway. A nucleus is robbed out, the bees become cross and sting passers-by. Perhaps a span of horses is attacked; a runaway follows; damages are claimed, and another lawsuit is begun.

In the foregoing possible instances have been supposed. It is only fair to state that they are only types of what has occurred and may occur again, so it behooves the beekeeper to be careful.

In the first case mentioned (the aggrieved neighbor's washing soiled by the stains from bees affected with dysentery), it is well for the beekeeper to send over several nice sections of honey, or to offer to pay for the damage done to the washing. Nothing makes a woman more angry than to have her nice clean white linen, after she has rubbed, rinsed, and hung it out to dry, daubed with nasty, ill smelling brown stains. But if the beekeeper shows a disposition to make the matter good and takes pains to offer an apology *before* the woman makes complaint, trouble will in most cases be averted. And right here it should be said, if the bees are in the cellar they should not be set out on a wash-day; or if they are outdoors, and the sun comes out bright so they begin to fly strongly from the hives, one should send word to the neighbors and ask them not to hang out their washing, if it is a washday, for a few hours. It might be well also to send along a few boxes of honey, and keep the folks across the way "sweetened up." With such treatment most neighbors will put up with a great deal of inconvenience.

As to the more serious cases—those in which horses or cattle have been stung—if the beekeeper has been foolish enough to place hives near the highway or near his neighbor's line fence where he has loose stock, he may have to pay pretty dearly for it before he gets through. The remedy is prevention. He should always put his bees in the back yard, and not too close to a neighbor's line fence. He should be careful, also, to prevent robbing. He

should see that there are no weak nuclei with entrances too large. As soon as the honey flow stops, he should contract the entrances of all the weaker colonies. If extracting is done after the honey flow, great caution needs to be exercised. The extracting-room should be screened, and no honey left exposed to the bees. Whenever possible, he should take off all surplus by the use of bee escapes rather than by shaking. (See Robbing and Extracting.)

Under the head of Anger of Bees, in the latter part of the article, and under the head of Apiaries, emphasis is put upon the importance of placing the hives so that they shall be screened by shrubbery or small trees from other hives and objects in the yard. Nothing is more conducive to insuring good temper on the part of bees than to place the individual hives so that the inmates from their own doorsteps can not see moving objects in the immediate vicinity. When the space where the apiary is located is open, without shrubbery or trees to screen the hives, the bees are much crosser than when placed behind obstructing objects. The average back-lot beekeeper will have much better bees to handle, and no trouble with neighbors, if he puts his hives among the bushes. If he has a high board fence, or a hedge of evergreens to shut off the little apiary from passing teams, pedestrians, or children that play in the next yard, the conditions will be much better. (See Back-lot Beekeeping, also Laws Relating to Bees.)

BEES, DO THEY INJURE FRUIT?—Occasionally complaints have been made that bees injure fruit. To a casual observer they apparently do bite through the skin and extract the juices until the specimen is shriveled up to a mere semblance of its former shape and size. However, careful investigation has shown repeatedly that bees never injure sound fruit, no matter how soft the skin nor how juicy and pulpy the contents.

Among the progressive fruit-growers and horticulturists there is a general acknowledgment that bees do not injure sound fruit; that the little harm they do to damaged fruit is compensated for a hundred times over by the indispensable service they perform in pollinating fruit blossoms early in the season when no other insects or means of pollination exist. The best fruit-growers are now keeping a few colonies of bees in each of their orchards. Often they invite beekeepers to locate yards of bees either in the orchards or as near as it is practicable to put them. (See Fruit Blossoms.)

Some years ago, Prof. N. W. McLain, then in the employ of the Department of Agriculture, Washington, D. C., conducted an elaborate series of experiments in which he placed sound fruit, consisting of grapes, peaches, apricots, and the like, in hives containing bees that were brought to the verge of starvation. This fruit was left in the hives day after day, but it was never once molested. Then he tried breaking the skin of the fruit, and in every case all such specimens were attacked by the bees and the juices sucked out until nothing but a dried skin and the stones or seeds were left.

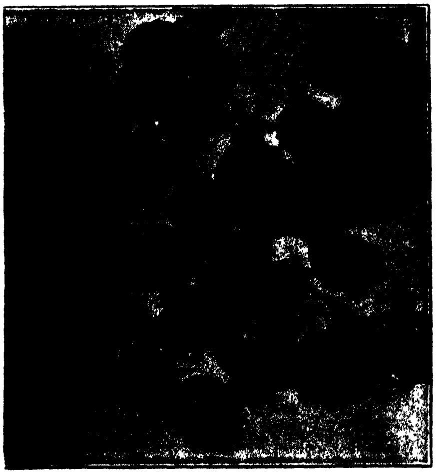
Years later, Prof. H. A. Surface, then economic zoologist at Harrisburg, Pa., tried a similar experiment, but in no case did the bees attack sound fruit, although they partook freely of that which he had broken.

At the Wilmington State Fair, held in September, 1908, in Delaware, Joel Gilfilan, of Newark, Del., had on exhibition a three-story observation hive containing two combs of bees. In the third story were hung a peach, a pear, and a bunch of grapes. This hive was kept on exhibition during the entire fair where the general public could see it. As is shown, this fruit was never once visited by the bees. The general verdict of those who saw it, fruitmen and farmers alike, was that bees did not injure this fruit.

The publishers of this book have had, during the past 60 years, colonies located in a vineyard at their home apiary. Nothwithstanding hundreds and hundreds of pounds of grapes are raised every year, the bunches hanging within three or four feet of the entrances of the hives, the sound fruit is never injured; but during a dearth of honey a broken or otherwise bruised bunch of grapes will often be visited by a few bees.

But a casual observer might easily get the impression that bees not only suck damaged fruit dry, but actually puncture and eat the sound fruit. Some years ago a neighbor sent word that he would like to have us come to his vineyard and he would give us indisputable proof that our bees were actually puncturing his

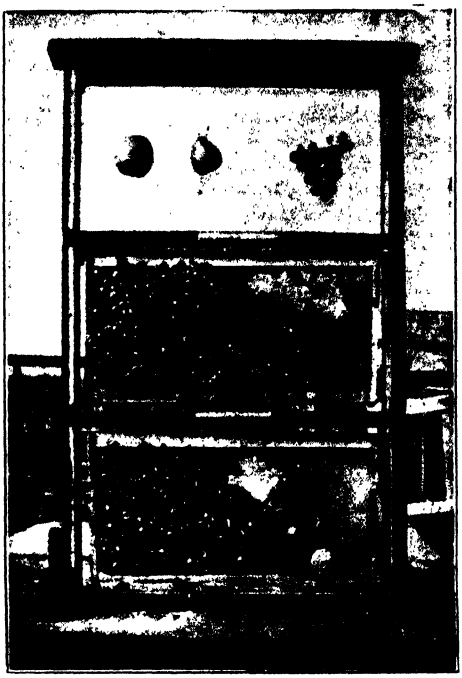
grapes and sucking out the juice. We looked at the luscious bunches as they were hanging down, and, sure enough, there were small needlelike holes in almost every grape that the bees were working on. It looked like a clear case of "caught in the act" evidence against them. For the time being we were unable to offer a satisfactory explanation. We brought the matter to the attention of an old farmer who had been a beekeeper for many years. Finally one morning he sent word to us that he had found the culprit, and that if we would come down to his place *early* some morning he would point him out. This we did. He showed us a little bird, quick of flight, and almost never to be seen around the vines when any human being was present. This bird, about the size of a sparrow, striped, and called the Cape May warbler *(Dendroica tigrina)*, has a long sharp needlelike beak. It would alight on a bunch and, about as fast as one could count them, would puncture grape after grape. After his birdship has done his mischief he leaves, and then come the innocent bees during the later hours of the day and finish the work of destruction by sucking the juices and the pulp of the grape until it becomes a withered skin over a few seeds. Thus the



Grapes punctured by birds and despoiled by bees.

grapes were punctured by the birds during the early hours of the day; but the bees, coming on later, received all the blame for the mischief.

The Cape May warbler is not the only bird guilty of puncturing grapes. There



One of the exhibits of bees at the Grange fair, in Wilmington, Del., held in September, 1908. A card in the hive reads, "Bees do not injure sound fruit."

are many other species of small birds that learn this habit, and among them may be named the ever present sparrow and the beautiful Baltimore oriole, the sweet singer that is sometimes called the swinging bird, from its habit of building its nest on some overhanging limb.

Some seasons the bird visitors are much more numerous than others. Several years may pass before any complaint is made, and then the beekeeper will have angry people in the vicinity of his bees calling him on the telephone, saying the bees are eating their grapes. The thing to do is to call on each complainant, and prove that the birds are the ones that do the mischief in the first place, and that it is only by careful watching at intervals that they can be seen at their work.

In order to determine their presence the observer should go away from the grapevine about 50 or perhaps 100 feet. The early morning hours are the most favorable for catching the miscreant at work. The Cape May warbler is a shy little fellow, and he will not usually show himself

if any one is near the vines. It is for that reason that the bird is seen on the grapes only at brief intervals; and the bees, working on the bunches all day, get the blame for all the damage.

Cracked and Punctured Skins of Fruit

Bees will not injure or bite through the skin of sound fruit. From a physiological standpoint they are incapable of doing this, and they never do; but bees will suck the juices out of overripe grapes and other fruits, which, after a brief period of hot weather and frequent rains, develop so rapidly that their skins crack. Such fruit is already damaged, and would not keep very long. In the case of overripe grapes where the skins have cracked, bees will do damage. Such overripe fruit has a market value if sold at once. Before it is picked, the bees will visit the bunches and leave nothing but shriveled skins. In this particular case bees ruin the sale of fruit already damaged but having a market value if sold immediately.

Bees are often wrongly blamed for the work done by other insects equipped with cutting jaws, as well as by certain varieties of birds. When the skin of any fruit is broken from any cause, the bees will suck out the juices, provided no honey is coming from the blossoms.

Yellow-jackets are well equipped with cutting jaws. They are very fond of fruit. They will cut through the skins, suck what juice they want, and, later on, the bees will visit the same punctures. The bees are, of course, more numerous, look like yellow-jackets, and are by the uninitiated given blame for all of the mischief —puncturing as well as sucking the skin dry.

Yellow-jackets are particularly numerous in the fall after a frost. They cut through the skins of fruit unpicked; and the bees, because the frost has killed natural sources of nectar, will help themselves to fruit juice made available by the previous act of the yellow-jackets.

For further information regarding grape-puncturing birds, refer to bulletins by Dr. Merriam of the United States Department of Agriculture, Washington, D. C.

When Bees May Damage Fruit

There are times when bees are a nuisance, and it is then that their owner should compromise, or better still, seek means to avoid trouble in the first place. In the fruit-drying ranches of California, apricots and peaches are cut up into small pieces and laid upon trays exposed to the sun's rays. If there is a dearth of honey at this time, and a large number of bees in the locality, this fruit may be attacked. The bees may visit it in such large numbers that they suck out the juices, leaving nothing but the shriveled form of the fruit. The property is, of course, damaged, and its sale ruined. Before anything of this kind can happen, the beekeeper should move his whole yard to a

Apricots damaged by birds; fruits thus injured are sucked dry by bees, which store the juice as honey.

point three or four miles distant from any fruit-drying operations. Failing to do so the fruit-grower, if the bees caused trouble, might enter suit for damages, and possibly recover the value of his crop.

Years ago we had trouble with a cider-maker. He claimed that our bees would lick up the cider from the press as fast as he could make it. We easily adjusted this difficulty by screening his building with mosquito netting.

In every case of this sort the owner of bees should avoid trouble. In the case of the fruit-drying ranches and the cider mills, the beekeeper should err on the safe side by avoiding suit for damages, because no lawyers would be able to give much assistance where it was clearly proven that the bees were doing an actual damage.

Bees Exonerated by a Jury

In 1899, trouble arose at Amity, N. Y., between two brothers named Utter. One was a beekeeper and the other a fruit-grower. The latter averred that the former's bees punctured his peaches, and, in consequence of the alleged damage, he claimed he was unable to raise any fruit. There had not been very good feeling between the brothers for years. The fruit-grower brought suit against the beekeeper, and the case was tried on December 17, 18, and 19, 1899, at Goshen. There was no lack of legal talent on either side. The case was a very hard-fought one from beginning to end. Among some thirty witnesses examined, the Government expert, Frank Benton, then of the United States Department of Agriculture, Washington, D. C., gave his testimony to the effect that bees never puncture sound fruit; that it is impossible for them to do so, owing to the fact that they have no cutting jaws like those found in the wasp and other insects of that character. He also showed that wasps and birds will, under some conditions, puncture fruit; that these minute holes they make will, during a dearth of honey, be visited by bees. Other expert testimony was offered, nearly all of which exonerated the bees. After all the evidence was in and the arguments were heard, the jury returned a verdict for the defendant.

For further particulars regarding this, the reader is referred to Gleanings in Bee Culture for June 1, 1900.

In case trouble arises, the owner of the bees will do well to read Bees as a Nuisance, and also the other subject found in its alphabetical order, Laws Relating to Bees.

BEES, CROSS.—See Anger of Bees.

BEES, CROSSES OF.—See Hybrids.

BEES, HANDLING.—See A B C of Beekeeping, Manipulation of Colonies, and Honey Exhibits.

BEES ON SHARES.—In some localities, notably in California, Colorado, and the great West, bees are sometimes kept on shares. While this method of doing business has often been conducted quite successfully and satisfactorily to both parties, yet many disputes have arisen, perhaps because there was a lack of contract; or, if there was one, there was nothing in it to cover the point in dispute.

The following form of contract was very carefully drawn by an attorney, and it is hoped it will meet every condition:

ARTICLES OF AGREEMENT

This agreement, made and entered into at ——, this —— day of ——, 19—, by and between — —of ——, party of the first part, and hereinafter called the owner, and ——, of ——, party of the second part, and hereinafter called the employee.

Witnesseth: First, that said owner has agreed, and in consideration of the covenants and agreements herein contained and to be performed by said employee, does hereby agree to provide a good location for keeping bees, at or near ——, and furnish and put thereon, on or before the —— day of ——, 19—, not less than —— colonies of healthy bees, and then and thereafter at such times as needed during the continuance of this contract, to provide and furnish at his own cost and expense, all hives, tools, implements, machinery, and buildings necessary to enable said employee to carry on successfully the business of producing and securing honey and wax from said bees; and further to pay one-half of the cost and expense of all sections, cans, bottles, shipping cases, and packages that may be required to put the honey and wax into marketable shape; and in case it shall be necessary to feed said bees, to provide and furnish feeders and sugar for making the syrup; and said owner further agrees to give and deliver on the

said premises, to said employee, as and for his compensation for labor done and provided by him in caring for said bees and securing honey and wax, the full one-half of all marketable honey and wax produced and secured from said bees.

Second: In consideration of the above covenants and agreements, the said ——, employee, hereby agrees to enter the employ of said owner on said —— day of ——, 19—, and at once care for said bees in a proper manner; do, perform, and provide all labor necessary to carry on successfully the business of producing and securing honey and wax ready for market; pay one-half the cost and expense of all sections, cans, bottles, shipping cases, and packages that may be required to put the honey and wax into marketable shape; feed the bees, when necessary that they shall be fed, and deliver on the premises to the said owner the full one-half of the marketable honey and wax produced and secured from said bees, and to accept the remaining half as and for his full compensation for labor done and provided by him in the care of said bees and the production and securing of honey and wax.

Provided, and it is mutually agreed and understood by and between the parties hereto, that said employee shall double up all of said hives at the close of the season or leave them reasonably strong and well supplied with stores and prepared for winter; and if any of said colonies of bees are lost through the carelessness or negligence of said employee, said owner may recover from said employee as damages an amount not greater than one-half what it would cost to replace said bees and queens; all increase of swarms (artificial or natural) to belong to said owner. It is further mutually agreed and understood that in case no honey is secured, or the amount runs below ten (10) pounds per colony, said owner shall pay to said employee, as and for his compensation for all labor done and provided by him on and about said bees, an amount not exceeding —— cents per hour for each and every hour of labor so performed, and provided by said employee on and about said bees, and in such case all honey to belong to said owner.

Signed in duplicate by said parties, the day and year first above written.

Signed in presence of —— ——

—— —— —— ——

—— ——

The foregoing comprises the essential features of a contract; but local conditions may render it necessary to make some modifications.

The contract as drawn would be very favorable to the owner of bees, provided he could always have a competent man and a good season. If, for example, he had 500 colonies, and secured an average of 100 pounds per hive, he might make something like 100 per cent on his investment. But if the employee is incompetent, or not strictly honest, or if the season were poor or a failure, the owner might actually lose money. The contract, as drawn, assumes that the average employee will not get as much out of the bees as the owner, moreover if the employee is a little careless, foulbrood might start among all the bees. Even if the season were good, the cost of treating the entire apiary, and the reduction in crop by reason of the ravages of disease, might likewise cause an entire failure. On the other hand, the employee, even if he had done his best, might lose out also, if the season were a failure. For that reason the last clause in the contract is inserted as a matter of fairness to him.

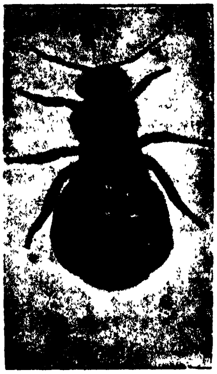
If no honey should be secured, he has performed his part of the contract in good faith, and, moreover, has improved the apiary—perhaps increased it—so that it will be in better condition the following year for a honey crop. For this betterment it is no more than fair that the owner should pay his man a reasonable sum, whatever amount may be agreed on; or, if preferred, a certain number of colonies. One can readily see that, in case the honey season were an absolute failure, the employee would suffer a total loss except for a provision of this kind, and the owner would still have his bees, the increase, his implements, and everything necessary to carry on the business for another season.

By the above contract it is to the interest of both parties to keep down increase. The employee must know, if he is a practical beekeeper, that, the greater the increase, the less the honey; and he will, therefore, bend all his efforts and skill to keep the colonies in the best condition to obtain a crop of honey.

Keeping bees on shares is practiced quite extensively in Colorado and California. It very often happens that a beekeeper lately arrived from the East desires to try a locality to determine whether it will be suited to his health and whether or not he can make the keeping of bees a success. He accordingly finds a beekeeper whose other business

leads him to desire some one competent to manage his bees for him. But where one is well settled in a locality, and has the means whereby he can purchase the bees, he should do so.

BEES, STINGLESS. — The stingless bees have been reported to be destitute of all offensive weapons, but this is in-



Stingless queen, twice actual size.

correct, as the sting is present, though vestigial and feeble and no longer used for defense. While they are not possessed of a real sting, they can bite and squeal, which makes some species of them to be feared. In the mountains of Venezuela, says Humboldt, they are called *angelitos*, or little angels, because they very seldom sting. But he confesses his alarm when he found his hands and face covered with them, and his confidence was not wholly restored by the assurance of his guides that they would not attack unless their legs were seized.

They differ very widely in disposition. Some are so gentle and timid that they do not attempt to defend their nests, while others in countless numbers make such a furious onslaught that their despoilers are forced to make a hasty retreat. In Guatamala *Trigona jaty*, a little yellow-colored bee, is so timid that it will not come out of its nest when stems are poked into the entrance; while another *Trigona*. rests quietly on the skin without attempting to bite. But a black species *(T. cupira)*, nesting in the ground, attacks furiously when its nest is disturbed, humming loudly, biting the face and neck, getting into the hair, and filling the eyes and ears. When Wheeler disturbed a nest of a variety of *T. flaveola* a multitude of bees rushed upon his face and hands, emitting a scalding liquid from the poison glands which had the odor of rancid butter. The corrosive action of this liquid rendered the skin very sensitive and painful to the touch for several days.

The stingless bee, or *Meliponidae*, are a peculiar family comprising about 250 species, of which four-fifths are found in tropical America, extending from the United States to southern Argentina, and the other fifth occurs in Africa, India, and Australasia. There are two well-defined genera: *Trigona*, found in both the Old and New World, and *Melipona*, a native of America only. A third genus, *Tetrasoma* has been proposed, but it differs but little from *Trigona*.

The species of *Trigona* have the thorax and abdomen nearly bare and in flight resemble little dance flies. To this genus belong a number of the smallest bees known. In a nest of *T. carbonaria* from Australia nearly 500 workers were counted and 250 honey pots. Larger nests, it has been estimated, may contain 80,000 individuals. In Panama, in a nest that

Stingless worker, twice actual size.

measured six feet in length, occupying the hollow of a decaying tree, the multitude of bees was apparently countless, appearing like a black cloud.

The honey of *Trigona jaty* is very sweet and has an aromatic odor. A palatable and wholesome honey is also made by *T. cupira*, which chiefly visits the flowers of the pulse and mimosa families. But as a number of species visit garbage pails, carrion, cow dung, and other noisome substances from which they gather material to mix with wax for making cerumen, the honey is likely to contain disease-breeding bacteria. The honey of *T. ruficrus* is black-

ish brown, odorless, of a nauseating acidly sour flavor, with a strong acid reaction. Complaints have been made of the baneful effects which have followed eating the honey of South American species of stingless bees.

The *Meliponas* are larger than the *Trigonas*, and the thorax is rather densely pubescent. The tibia is very broad and carries a large pollen basket, but the metatarsus is nearly smooth on the outside. The nests of *Melipona* are smaller than those of *Trigona*, the number of individuals ranging from 500 to 4,000. The bees of this genus attack bravely, but they are unable to puncture the tenderest skin.

Gardner, in his travels in the provinces of Goyaz and Piauhy and Brazil, found the *Meliponas* very numerous; and their honey, which has a pleasant flavor, was found in every house. Their nests were built in hollow trees or in banks, or suspended from branches. From a nest of a large species of this genus native in Venezuela eight quarts of honey have been obtained at one extracting. A smaller species in Cuba produces only a few quarts. The honey is of a light amber color, rather thin, and has an agreeable flavor. It has a ready sale at a fair price among the native Cubans, who esteem it as a medicinal remedy.

The nests of this family of bees are built in a great variety of situations, as in hollow tree-trunks, in the ground, and on the limbs of trees. In Cuba a nest was found in a termite nest two feet in diameter and built on the trunk of a tree not far from the ground. They are black or brown in color and are made of "cerumen," a mixture of wax and earth. The wax is exuded from the dorsal abdominal segments of the worker, and, strange to say, also of the male. Neither the male bumblebee nor the male honeybee ever secretes wax. The entrance to the nest may be merely a round hole, or it may be through a fragile tunnel or spout of wax. It is defended by a guard of workers, and at night by some species is closed by a plate of wax.

The brood combs are built horizontally, like those of the social wasps, and consist of a single layer of hexagonal cells, which open upward instead of downward. They may be all of the same size, or the cells in which the queens are raised may be larger than the worker cells, as in some south American *Trigonas*. The nests of some *Meliponas* are divided into two parts, in one of which are the brood combs and in the other large deep round cells, which contain the honey and pollen. A number of species of *Trigona* build primitive isolated brood-cells resembling those of the solitary bees.

The workers provision the brood-cells with bee-bread, or a mixture of pollen and honey, on which the queen lays an egg. The cell is then sealed over with wax, and the larvae developed without being fed after the manner of solitary bees. A larger quantity of food is placed in the queen-cell than in the worker-cell. There are three castes in a colony, queens, males, and workers. The abdomen of the stingless queen is gravid or swollen, almost orbicular in shape, and her wings are shorter and weaker than those of the honeybee queen. Because of her inability to fly well she does not go forth with the swarm, but in her instead the swarm is accompanied by a young queen, several of which are tolerated in a colony.

In southern Mexico, Central America, and South America the natives often have near their dwellings hollow logs containing colonies of stingless bees, which they have brought from the forest. The logs are suspended by ropes to trees to protect them from lizards, one of their chief enemies. At stated intervals the nests are robbed of their honey, a keeper being well satisfied if he can secure a gallon of honey from a single hive.

The quality of the honey and wax varies very much, in some cases being very good, in others quite the opposite. The wax is apt to be mixed with propolis to a great extent, as the stingless bees are prone to gather gums, resins, the sticky exudations of plants, and even oil from oil barrels. But a merchantable wax has been frequently sold in this country, which was produced by stingless bees living on the upper tributaries of the Orinoco in Colombia.

There is no probability that the stingless bees will ever rival the honeybee in the production of honey. In nests, where the bees store the honey and pollen in large cells apart from the brood comb, it is difficult to obtain the honey unmixed with other substances. It would not be safe to use the honey of species which visit offal and unclean excretions, much as flies do. But these objections do not apply to the honey of all the spe-

cies, which, as has been stated, is frequently pleasant in taste, wholesome, and widely gathered and sold. There are natives in South America who consider the stingless bees superior to the "stinging fly" of the white man.

BELLFLOWER.—See Campanilla.

BLACK BROOD.—See Foulbrood.

BLACK GUM.—See Tupelo. Also called black tupelo and water tupelo, a forest tree growing in swamps from southern New Jersey to Florida and Louisiana. See the book, "Honey Plants of North America."

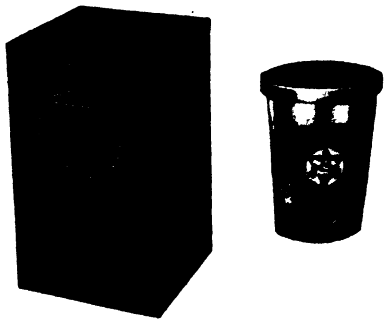
BLIGHT.—See Fire Blight.

BORAGE *(Borago officinalis* L.).—See "Honey Plants of North America."

BOTTLING HONEY.—When honey is put into any other container than glass it is impossible to determine its character, its color, or its specific gravity, that is, how thick it is. When put into glass its color attracts the eye and teases the palate. When a bottle of it is turned upside down a large air bubble in the form of a beautiful transparent sphere will slowly rise, thus indicating that the contents are not only beautiful in color, but thick and waxy.

There are thousands upon thousands of people who do not eat honey. In order to interest them it is first necessary to tease their appetite by showing them an article that is externally attractive as well as intrinsically good. For this reason honey in a retail way and for table use is usually sold in glass just as jellies and jams and all other commodities of like nature are sold. After the consumer, or more exactly the housewife, who buys the food, discovers what honey is from the purchase of a small bottle she will be interested in getting a larger supply in 2½, 5, and 10 pound pails or tin cans. The larger the package the cheaper the honey is per pound. The experience of the trade shows very clearly that she is going more and more to the large sizes. This is encouraging in that it will mean a much larger consumption of honey.

There is another class of customers, mainly working people, especially those in the cities, who can not afford to buy a large quantity of anything. They will purchase a little of this and a little of that, and perhaps a tumbler or bottle of honey. No matter how well they like it, they will never be able to buy a larger quantity. The probabilities are they will never get to the stage of buying their



foods in large quantities at a time. For this class of people (and it probably represents a large proportion of the honey buyers) the glass package is the best suited.

Putting Up Honey in Glass

For a small local trade it is customary to use white flint Mason jars, large and small sizes, and jelly tumblers, such pack-

ages as can usually be obtained from the grocery store. Either Mason jars or jelly tumblers can be used over again for holding canned food or for jellies and jams. The reason that these two glass packages are used so generally is because the housewife does not complain of the cost of the containers because she can use them over again.

There are some who will prefer the regular honey bottle with screw cap, holding from a few ounces to a couple of pounds. These can be secured from the dealer in beekeepers' supplies. They make a very pretty appearance and when placed alongside the Mason jars and jelly tumblers the customer can select for herself. As a rule, the fancy trade in the large groceries, especially in the cities, prefers the regular honey jars, especially where the amount of honey is small. Jelly tumblers can be had in large and small sizes, and perhaps for country towns they are preferred to small honey jars holding equal amounts.

Labels for Glass Jars

Labels should be neat and attractive. As a rule, the local printer has no idea as to how to make up an attractive label. It is not in his line and therefore the bottler should buy his labels from his regular bee-supply dealer, who will furnish him a label catalog giving a large assortment of different sizes in different colors. The name and address of the bottler can be put in black ink or any other color of ink at a very small cost on stock labels. As a rule labels made by people who make a special business of doing such work are cheaper than one can buy locally of a printer who is not equipped to do color work.

The labels should be relatively small because it is the honey that is attractive, and which is supposed to make the sale. If the label is too large for the package it covers up the honey.

The National Pure Food Law, and in most cases state laws, require that the labels shall indicate the exact contents of the package in pounds and ounces. Anything under a pound should be stated in ounces. Anything over a pound should be stated in pounds and ounces. It is contrary to the ruling to make a label read, for example, 36 ounces net weight when it should read 2 pounds and 4 ounces net weight. The purpose of this is to prevent confusing the consumer by a statement which may be misleading.

It is illegal to say "Pure Clover Honey," when some other honey is used, as for example, alfalfa or mountain sage. It is very much wiser to use the simple words, "Pure Honey," and then it will be possible to use a blend of any honeys that one may happen to have on hand or any honeys that one can purchase at a fair price.

In this connection it should be stated that only the best light-colored honeys should be used. White clover, sweet clover, alfalfa, mountain sage, and orange blossom are all good. In the South, sourwood, gallberry, tupelo, palmetto, mesquite are all excellent. In most locaities of the North or South the average beekeeper will not have enough of any one particular kind of honey to supply his trade. He will therefore find it necessary to make up a blend of his best white honeys. In the West alfalfa and sweet clover will be the main sources in the northern states, and, of course, will be the only honeys used. The large bottlers use a blend which they keep the same from year to year.

The Advantage of a Blend of Honey

This blend usually consists of white clover, sweet clover, alfalfa, and sometimes mountain sage, and sometimes orange blossom. This makes it possible to keep the blend always the same. If one year a beekeeper puts up white clover only and

the next year alfalfa, and the year after that buckwheat, the average customer becomes suspicious and wonders whether the honey is adulterated because it does not taste like what he had the year before. If, on the other hand, the honey is always the same, consisting of a blend of the very best honeys, the consumer will buy from year to year.

Washing and Cleaning Bottles

Some use bottles just as they come from the bottle works, without washing. It is far better to run them through a tub of warm water to rinse out the dust and sometimes small particles of glass. The bottles should then be allowed to stand upon a tray upside down where they will dry out shortly, if the water is hot enough. The mistake should not be made of having the water too hot, as it will be liable to break the glass; and, moreover, it would make it almost impossible to handle the bottles.

Preparing the Honey for the Bottles

By referring to granulation, it will be noted that all pure honey, with the possible exception of tupelo and mountain sage, will granulate in from a few weeks to a few months, especially after cold weather comes on. (See Granulated Honey.) Whether honey is granulated or not it should be heated to a temperature of from 150 to 160 degrees Fahrenheit—certainly not higher than 160. The honey should then immediately be bottled and sealed while hot. If honey is allowed to cool off before sealing it will granulate again, possibly within a year's time or less.

Some believe that a lower temperature of 120 to 130 degrees will answer the purpose, but it will then be necessary to keep the honey hot a much longer time. Experience shows that continued heat at lower temperature has more of a tendency to impair the flavor than a short or quick heat at a higher temperature. In order to prevent its getting too high, it is necessary to use a good dairy thermometer. When the temperature reaches about 150° F. it would be well to stop at this point because there is always danger of going too high if the honey is left on the stove or radiator too long, especially if the honey was granulated in the first place.

While the large bottlers use double boilers, one tank inside of another with water between the two tanks, it will be the purpose here to show how a small beekeeper, desirous of taking care of his local trade, can heat his honey safely without the expense of a double boiler or any special apparatus. Under Granulated Honey the reader will find directions for liquefying honey in a large way. The average small beekeeper, however, will not find it necessary or perhaps wise to liquefy the contents of more than one or possibly two sixty-pound square cans of honey at a time. If the honey is not granulated it should be heated just the same. Bring the temperature up to 150°, certainly not higher than 160° F., and then bottle while hot. If the honey should be granulated, then the can containing it should be placed on top of a steam or hot-water radiator, such as is used for heating houses, or on or next to a register of a hot-air furnace. During winter weather the heat will be sufficient to reduce this honey to a liquid condition in a few hours. When the hot water or steam radiator is used the can of honey may be laid upon its side on top of the radiator. In a couple of hours examination should be made by turning the can upright to see if the honey is beginning to liquefy. The temperature should be taken with a dairy thermometer, already mentioned. If the honey is all liquefied and the temperature is not above 120° the can should be allowed to stay on the radiator until the temperature reaches 150°. If one can be sure not to let it go higher than 160 degrees it would be well to use the latter temperature, then take the honey off, immediately put it into bottles and seal while hot. One is not liable to overheat the honey on a steam or hot-water radiator.

Perhaps there are some people who do not have either a furnace or a steam or hot-water boiler in the house. In that case an ordinary oven of a stove will do very well. First lay a couple of sticks of wood about ⅞ inches square upon the floor of the oven. Then place the square can upon its side on them and allow it to remain in the oven until the contents become liquefied; but it would be well to remove the can from time to time to take the temperature, so that the honey will not be overheated. In a common ordinary stove oven there is very great danger of the honey being overheated. After one has had experience with a can or two he can determine about when he

ought to take the honey out. To prevent overheating the honey in the oven it would be well to leave the oven door open.

Altogether the best plan of liquefying from a hundred to two hundred and fifty pounds of honey without the danger of overheating, is one devised by C. H. Gilbert, Assistant Research Agriculturist, of the University of Wyoming. His description, with the illustrations is taken from Gleanings in Bee Culture, page 524, for 1933:

In order to handle our honey efficiently we have designed and constructed special tanks. Because of lack of space we must have a small, compact unit. Several beekeepers have looked over the set-up and are enthusiastic about it. This article has been written at their request. The tanks used and the principles involved are undoubtedly well known to many beekeepers, but, judging from local interest, they will be new to some.

Danger of Overheating

The big problem in processing honey is to prevent overheating. There are some beekeepers who refuse to heat honey and much can be said for and against it. I am convinced that damage to honey if properly heated has been greatly exaggerated. Be that as it may, we must agree that some heating is necessary to liquefy granulated honey.

The problem, then, is to heat it sufficiently to liquefy it without causing damage. If too much heat is applied the sugars will be burned. This darkens the honey and changes its flavor. To avoid this, correct temperatures must be applied for a certain length of time. The trouble is that many beekeepers have no idea of the temperature of the honey when it is being heated and fail to check accurately the length of time the heat is applied. The following example will illustrate this point.

A certain beekeeper liquefies honey in 60-pound cans by submerging them in a tank full of water. The process requires about two days. The honey begins to liquefy immediately, but the liquid honey can not drain off and the heat is applied to it continually until the entire sixty pounds is liquid. Thus it is probably injured by heating.

To prevent overheating during the process of liquefication we have made a small and inexpensive tank which permits the honey to run off as soon as it becomes liquid. This also speeds up the process considerably.

Construction of the Liquefying Tank

The liquefying tank shown in Fig. 1 is made to hold four 60-pound cans. The cans, held in position by angle irons, are placed in the tank to permit uniform distribution of steam throughout. The cans are placed on their sides with the opening in the lower corner. The tank is then closed by means of a cover (Fig. 1) in which four holes have been made to fit snugly over the openings in the cans. As the steam condenses the water drips to the bottom of the tank and is carried away through a small pipe. A close fitting cover with flange properly placed on the bottom (see lower part of cover Fig. 1) absolutely prevents the water from getting into the honey. The liquid honey drips from the can openings into a trough and flows from there to the heating tank, Fig. 2.

The liquefying tank can also be used where steam is not available. The drain is closed and about one and one-half inches of water is placed in the bottom of the tank. It can then be used over a gas flame or a coal stove. The honey is heated by the steam formed by heating the water. The water is heated over and over as the steam condenses. This method is somewhat slower than live steam, but it saves the trouble and expense of firing a boiler. A two-can capacity tank has given satisfactory results when heated over a coal range. Two hours were required to liquefy two 60-pound cans. In the four-can liquefier with live steam, four 60-pound cans of granulated honey can be entirely liquefied in one hour.

The angle-iron support should be inclined toward the back or bottom of the cans. Then as the cake of granulated honey becomes smaller it will slide toward the bottom of the can and thus leave the opening free. If this is not done, the chunk of granulated honey will block the

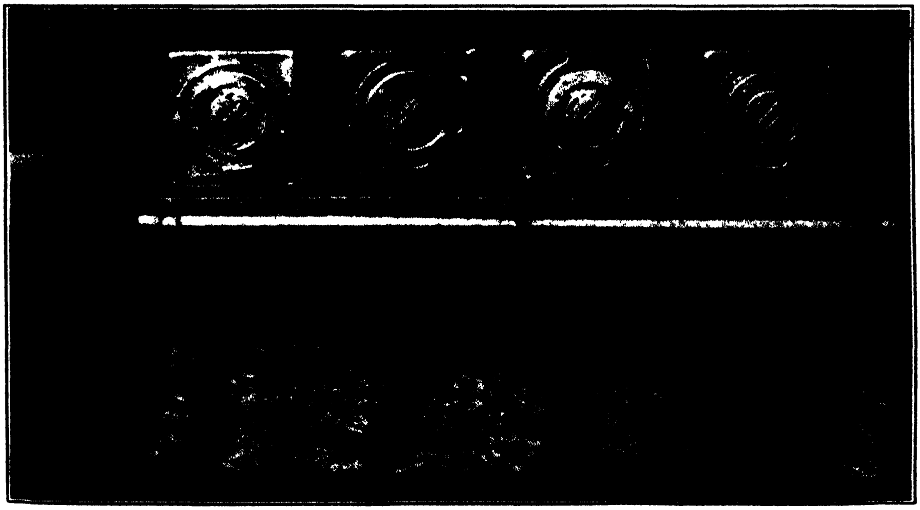


Fig. 1.—This small liquefying tank holds four cans at a time. The cans are placed on their sides with the opening at the bottom so that the honey will run out as it melts. The cover, with its holes to correspond with the screw-cap openings of the can, is shown below the tank.

opening and the honey may be overheated. Some liquid honey will be retained in each can, so the cans should be removed from the liquefying tank and emptied just as soon as the granulation has disappeared.

This type of liquefier can not be used when honey is cold and in a liquid or semi-liquid state. The honey spills from the can into an open trough and if it is not liquid and warm, the trough will not handle it. If the honey is liquid enough to run from the can it should be poured directly into the warming tank.

The Water-Jacketed Heating Tank

The liquid honey runs directly from the trough to a heating tank. This tank is shown at the lower right in Fig. 2. The honey in this tank is surrounded, except the top, by a two-inch jacket of water. The honey is heated to the correct temperature, which is retained as long as desired. The heating tank serves also as a clarifier. An open bottom baffle plate across the gate end of the tank helps to remove foam, wax, and sediment from the honey. When the honey is drawn from the tank it is passed through a fine mesh strainer. The capacity of the heating tank is, of course, the same as the liquefer.

The water jacket may be heated on a coal stove, gas flame, by steam, or by electricity. An electric plate is the ideal way, because the temperature can be controlled accurately by means of thermo-regulators. It is not recommended to the average producer, however, because of the cost of electrical energy and the expense of necessary regulators. No matter how the honey is heated the temperature must be watched closely. If steam is used the temperature can be regulated by the flow of steam. When heated on a cook stove or gas flame the temperature may be regulated by the size of flame, by the addition of cold water occasionally, or by removal from the stove. The electric plate has many advantages, but its use necessitates a greater cash outlay by the beekeeper.

The measurements of the tanks are given below:

LIQUEFYING TANK SHOWN IN FIG. 1.

	Left to right.	Front to rear.	Top to bottom.
4-can capacity	48 inches	16 inches	13 inches
2-can capacity	24 inches	16 inches	13 inches

The trough is tapered and is supported by V-shaped strap iron braces, which fit into slots on the bottom of the tank. These supports are not attached to the trough, and by changing them and reversing the trough the flow of honey can be changed from right to left.

The following are the measurements of the heating tank shown in Fig. 2, lower right. These measurements are inside only and do not account for a two-inch water jacket.

	Length.	Depth.	Width.
4-can capacity	32 inches	12 inches	13 inches
2-can capacity	18 inches	12 inches	13 inches

The measurements can be varied to fit the size of sheet metal available. The gate end need not be water-jacketed and considerable difficulty in attaching the honey gate and water valve will thus be avoided.

Another and cheaper plan, but not so good, is to set square cans down in a washboiler of hot water, the water itself to be not higher than 160 degrees. This boiler should be on the stove where the

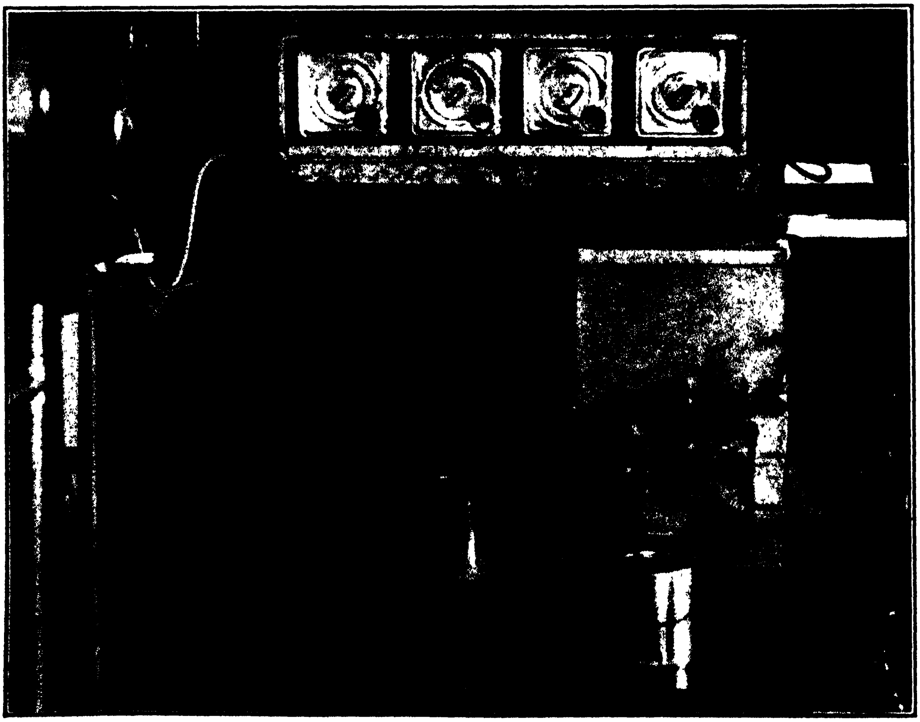
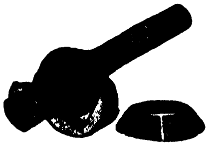


Fig. 2.—The four square cans are kept hot by low pressure steam circulating around and under them. This steam may come from a hose connecting a boiler, or it may come from the pan of hot water beneath kept hot by a stove or gas jets. The steam is confined by the lid shown on the previous page.

temperature of the water can be kept up until the honey in the can is entirely liquefied. To avoid burning the honey put a couple of cleats of wood down in the bottom of the wash-boiler and then the square can or two square cans of honey upon these cleats. If the boiler is of large size two square cans may be put in at a time. When the honey is entirely liquefied and has reached a temperature of 150 degrees, the honey should be removed and immediately put into bottles. At this point the reader should read what Prof. Richmond says under Granulated Honey.

How to Fill the Bottles

As almost every small beekeeper has a hand-driven honey-extractor he can use this to very good advantage in bottling. First remove the gear-bar and the reel inside. Thoroughly wash out and cleanse the can. Put this upon a bench or table and into this pour the hot honey. Just below the honey-gate place a lower table or box so that the mouths of the bottles will come just beneath. Place the mouth



Adjustable flow honey-gate. It can be easily and quickly adjusted so as to feed a stream of honey the full size of the bore or down to 1/8 inch.

of the bottle beneath the honey-gate, open the gate, allow the honey to run in and then quickly shut it off. It will take a little practice to enable one to fill the bottles so that each one will have the same amount of honey. If some bottles should be short in weight the pure food inspectors might put in a complaint, and it is important to have each bottle filled so that it will contain the exact number of pounds and ounces. It is better to vary on the side of giving a little more than not quite enough.

Gooseneck Bottle Filler

As it is a little difficult to handle the honey-gate to the extractor it is much better to use a special honey bottle-filler which may be obtained from the bee supply dealer. This can be attached directly to the honey-extractor or can, or it can be attached to the end of a piece of rubber hose, connected to the tank of hot honey. The latter arrangement is much better because it is then possible to move this bottle-filler from bottle to bottle without handling a single bottle.

Two methods of using honey-bottle filler.

Where one has much honey-bottling to do, especially if he supplies more than one town with his honey the special bottle-fillers will be found much more satisfactory than the ordinary honey-gate to an extractor, for the reason that one can regulate the exact amount of honey to each bottle. With the honey-gate it is necessary to fill the bottle with slightly more than the required amount and the difference in the honey saved would pay for the bottle-filler in a few days' use, and at the same time enable one to work much more rapidly and easily. With a bottle-filler one could take care of a trade which would require thousands of pounds of honey, and, of course, where there is a large amount of honey to be put up the rubber hose is a great convenience. Where the amount is comparatively small the bottle-filler can be attached directly to the honey-filling tank or extractor.

Bottling Honey in a Commercial Way

There are several large bottling concerns in the country that have put up honey in glass in an extensive way. During the active season they will send out two or three carloads of bottled goods a week. They have to employ expensive apparatus—something which, at the same time, will be sanitary. First the bottles must be washed and sterilized; the honey must be heated in large tanks, glass-lined, and it must then be conveyed to a bottle-filler which automatically fills the bottles just so full and no more. The bottles are then carried by a traveling belt to

The passing of the log gum in the South.

a capping-machine, and then to a labeling machine, and finally to the box which receives the packages after they have been sponged off.

For putting up honey in tin cans see Extracted Honey. See Colloidal Substances in Honey.

BOX HIVES.—It seems as if any description of box hives in a work to teach modern apiculture would be out of place. The facts are, there are thousands upon thousands of colonies kept in these old gums in the south Atlantic states, where there are more bees and beekeepers to the square mile than anywhere else in the United States.

These hives, as the name indicates, are merely boxes containing neither brood-frames nor movable fixtures. They usually consist of a rude, rough box about 12 or 15 inches square, and from 18 to 24 inches high. Through the center there are two cross-sticks, the purpose of which is to help sustain the weight of the combs built in irregular sheets within the hive.

At the close of the season it is the custom to "heft" the "gums." Those that are heavy are marked to be brimstoned, and those that are light are left to winter over for the next season if they can. The bees of the first named are destroyed with sulphur fumes, and then the bee-bread, honey, and everything are cut out.

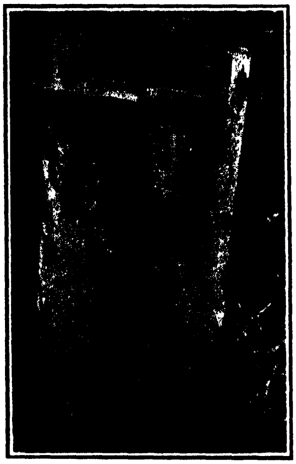
In the more modern box hives there are boxes with glass ends that can be drawn out from an upper part, leaving the lower intact. In this case the bees are not destroyed. In any case there is no opportunity to inspect combs, hunt queens, divide, nor perform any of the hundred and one operations peculiar to modern apiculture.

In Virginia, North Carolina, South Carolina, Alabama, and Georgia box hives or log gums are used very largely. Indeed, there are very few modern hives

An apiary of log gums in the South.

or modern beekeepers. The mountaineers in some of those states are of the purest of pure Anglo-Saxon blood. Their ancestors came from England 300 years ago. As their isolation up in the mountains

shuts them out completely from the outside world, many of the old customs and modes of speech still cling to them. They appear to be keeping bees in box hives or gums just as it was done in England



A modernized log-gum hive with removable cover, arranged to receive a super of sections.

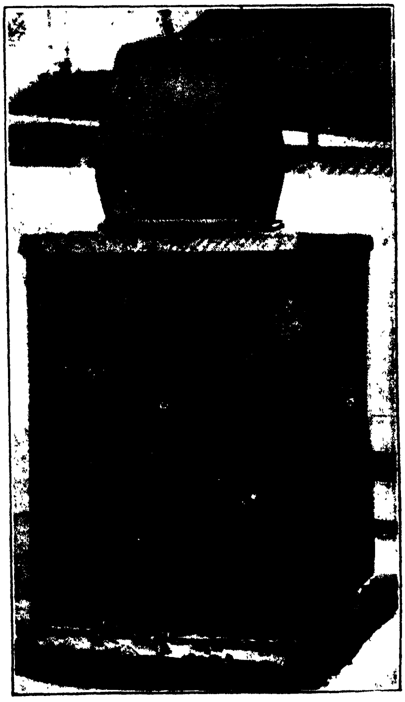
300 years ago. They have no knowledge of modern methods. The moth miller, swarming, and poor wintering are the handicaps that prevent them from getting much honey. The most of them, for example, know nothing of hiving the first swarms on the old stand, and placing the parent colony to one side or in an entirely new location in order to catch all the flying bees with the swarm. They leave the parent colony on the old stand, and of course it continues to swarm itself weak. In the meantime the moth miller and winter get in their destructive work. The result is that little or no increase is made, and the prime swarms are the only ones that yield any return. If foulbrood ever gets a foothold here, the business, such as it is, will be wiped out.

No matter what the season is, even though the crop has been only half harvested, the colony must be brimstoned and the honey taken off at some particular phase of the moon.

Possibly here is a case showing where, "if ignorance is bliss, 'tis folly to be wise"; but the United States, evidently thinking otherwise, has recently been sending experts into this country to teach modern methods; for statistics show that there are more bees and beekeepers in this Southland than in any other portion of the United States. The country is exceedingly favorable for the keeping of bees, and the day should not be far distant when modern apiculture will supplant the old box-hive system, coupled as it is with ignorance and superstition.

It is only fair to state that the class of box-hive beekeepers here described does not represent all of this Southland; but there are enough of them to require the earnest attention of the extension workers or county agents sent out by the Federal Government.

Extension men have done a splendid work in instructing the beekeepers of the southern states how to keep bees by modern methods. Many hundreds in the South are now transferring to modern hives; and with the new hives they are now following the new methods of management. It is needless to say that the difference in the size of the crops of honey so secured over the old way is so marked that the bee-extension men are



Typical box hive with an earthen crock for a comb-honey super. These crocks would be cold, but when once filled would keep the honey safe from leaking after taking off the gum.

being called upon to demonstrate how to transfer as well as how to keep bees better. C. L. Sams, special bee-extension man of the Department of Agriculture, Raleigh, N. C., is doing a wonderful work in educating beekeepers of his state to

Log-gum apiary of J. S. Kelly, near Wilmington, N. C. Mr. Sams holding an empty gum, and although the bees were stinging him unmercifully, he stood his ground while the picture was being taken.

the new ways of producing honey. Hundreds of beekeepers of his state are now transferring; and it is very evident that at no distant day the box hive, and with it its companion the log gum, will almost be things of the past, just as it is in the North at the present time.

Some of these people live in almost absolute poverty when they might just as well get a fair living, if they could but know of the modern methods of handling even box hives.

Moses Quinby (see Quinby) in the ear-

Modern hive into which bees in a "gum" had been transferred by Mr. Sams and his helpers.

ly '50's, handled box hives so that he made money; and if these people can not afford movable-frame hives, they could, by the simple expedient of hiving a swarm back on the parent stand and removing the parent colony, vastly increase their resources. Mr. Quinby did not brimstone his bees, and neither will these purest of pure Anglo-Saxons up in the mountains of the south Atlantic States be compelled to do so. Quinby's old book of 1853—a reprint of which has been made by the publishers of this volume — explains how bees can be kept on the box-hive system without the use of brimstone. While the tricks of the trade taught in this old work of Quinby would enable the Highlanders of the South to increase their yields per colony, the modern hive with movable frames would enable them to do much better.

BRACE COMBS. — See Thick-top Frames under Frames.

BREEDING STOCK—Every well-regulated apiary or series of apiaries should have one or more choice queens from which to breed. They should be the very best in the apiary, or, better still, the best out of a series of out-yards and the home apiary. They should not only be prolific but be the mothers of workers that are energetic and good workers—bees that will store more honey than any others. They should be of pure stock in order that they may the better transmit their qualities. While gentleness is desirable, it is sometimes necessary to sacrifice this desirable quality to get bees for business.

When using Italian stock one should not be misled by the fad of a bright golden or yellow color. If it comes about accidentally without the sacrifice of business qualities, the beekeeper is that much ahead. As a rule, the darker strains of Italians will show more desirable points than the bright-colored ones.

Ability to stand a severe winter is a necessary quality. It usually follows that bees that will breed up early in the spring, and prove to be good workers, are also good winterers. Bees that have difficulty in resisting the winter will be too weak, if they survive, to be good for anything in the season. It follows as a natural inference that a colony of bees that can pile up super after super of honey is also good for wintering.

It has been proven that some strains of bees will resist disease much better than others. While no stock is immune, there are some that do not readily contract disease, while others will fall easy victims. If possible, a breeding queen

should be one whose bees have demonstrated their ability to ward off disease, and there are some that have shown great superiority in this respect.

Good breeding drones should not be forgotten. It is generally accepted that a male is more able to transmit his good or bad qualities than the female; and the same rule holds good in bee culture. In selecting breeding queens one should select not only those that will produce good daughters but those that will beget good sons.

The average beginner should buy his breeding stock, especially if he has only a few colonies; and, even after he becomes fairly expert, if he has only one apiary he should buy a breeding queen of one of the best breeders in the country. A good queen is worth from $5.00 to $10.00 —usually the latter figure. Sometimes as much as $25.00 is paid. Usually a breeding queen is not less than one year old, for it takes at least a year, unless the season is exceedingly favorable, to measure her value. A queen one or two years old will not stand transmission through the mails like an untested queen that has just begun to lay.

After one receives a breeder he should give her the utmost care, not expecting that she will live more than a year, especially if she is already two years old. He must keep her in a small nucleus, for no breeding queen during the active season should be the mother of a powerful colony. She should be kept down, and given as little egg-laying to do as possible; and then in the winter, when the active season is over, her colony should be gradually built up with combs of emerging brood from other colonies. She should be given young brood in this way until she is the mother of a large colony, and then in addition she should be given every advantage by housing her colony in a large double-walled hive in a protected location. Or if one has a good cellar where he can control conditions, her colony should be placed indoors. (See Wintering Outdoors and Wintering in Cellars.)

The use of a good breeding queen may mean the difference between profit and loss in a year's business. It is folly to keep scrub cows on the farm when good cows on the same feed will furnish two or three times the milk. It is equally foolish to breed from anything but the best queen stock obtainable. A good strain of bees will produce anywhere from two to three times as much honey as a poor one. (See Queens and Queen-rearing.)

BROOD AND BROOD-REARING.—"Brood" is a term commonly used to designate the young of the bees that have not emerged from the cells. It may be young bees just before they come from the cells, the larvae in various stages of growth, or even the eggs.

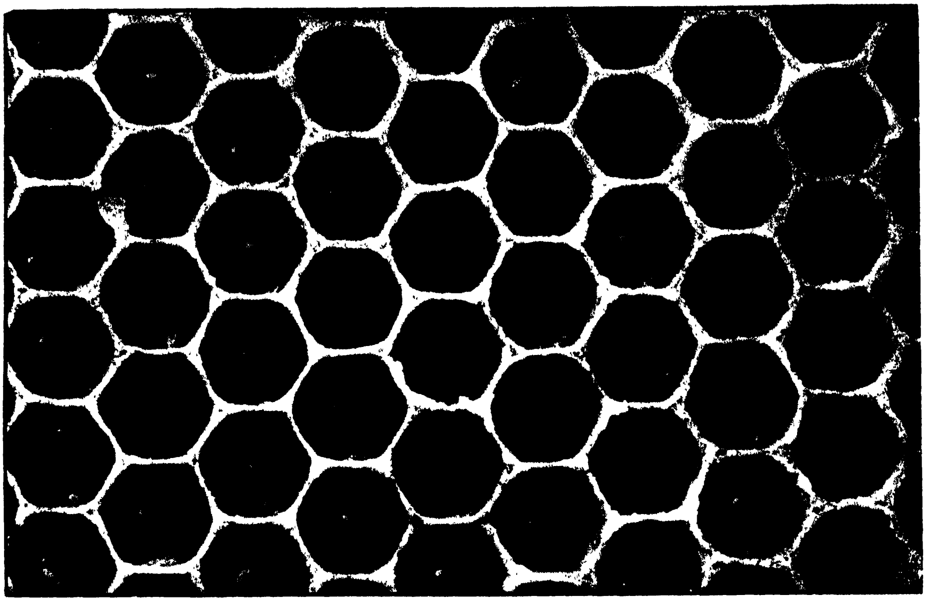
Sometimes the beginner is confused because he is not able to distinguish capped honey from capped brood; nor does he know the difference between drone and worker brood. Sealed brood is of a light to dark-brown color, depending on the age and color of the comb itself. In ordinary worker brood, in cells five to the inch, the cappings are made of wax and fibrous material, smooth and slightly convex if the brood is not diseased. Drone brood is the same in appearance except that the cappings are more convex with four cells to the inch. The cappings over honey are white, bluish-white, or yellow, are more or less irregular, and somewhat flattened. The honey may be in either worker or drone cells. By comparing the illustration shown on page 111, with the cappings of comb honey under Comb Honey, the beginner will easily make the distinction.

The beginner may not be able to see eggs at first. One trouble is, he does not know where to look nor what to expect. When he peers down into the bottoms of the cells and sees tiny little objects standing on end at an angle he hardly knows what they are. The cuts on next page show the eggs in the bottoms of the cells, although photography is not able to show the depth of the cell. The cut, page 117, shows brood in various stages of development.

How the Presence or Absence of Brood Reveals the Real Condition of the Colony

It is the presence of eggs or young larvae that shows that the bees have a queen and are beginning to rear brood. This may show even during midwinter if the weather has been warm for a few days; or it may occur, as it usually does, in early spring. Brood will be found in all stages of growth as the season progresses.

On the other hand, the absence of unsealed brood, and especially the absence



Close view of eggs. Notice the cell in the lower left-hand corner contains two eggs, while that at the right-hand corner has a larva.

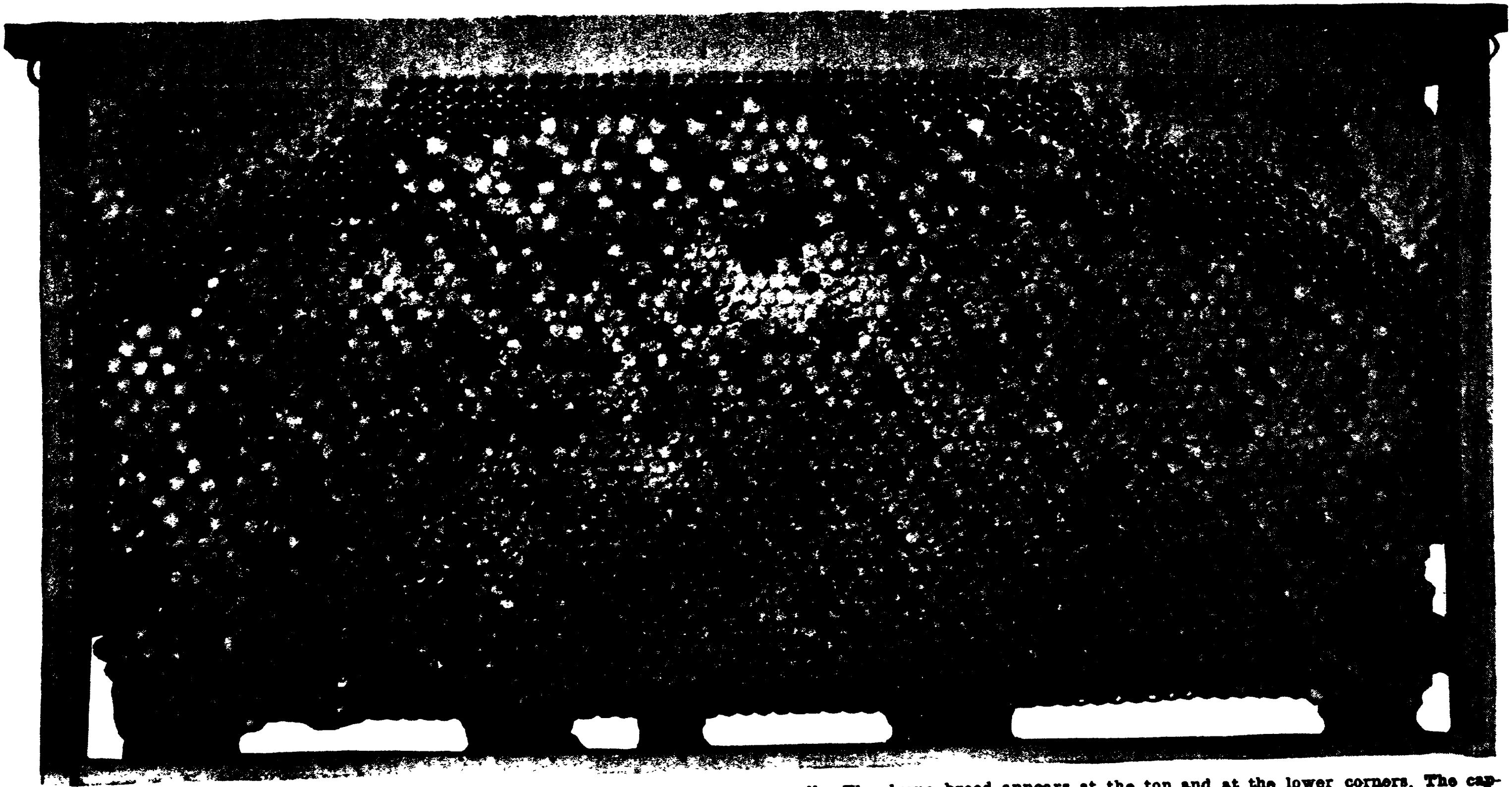
of eggs, may be an indication that the colony is queenless. During spring and early summer there will be, or should be, brood in all stages, including eggs. Such a condition indicates general prosperity, and the beekeeper can feel that his pets are doing well. But if there are no eggs nor young larvae, and the queen can not be found; and if, also, there are initial queen-cells during spring and the fore part of summer, the strong probabilities are that the queen has recently died or that a swarm has issued. It may further be said that the absence of eggs and the presence of initial queen-cells during the active season are almost absolute proof either that the queen is not in the hive, or that the one that is there is about to be replaced.

After the main honey flow, which usually occurs in the northern states from June 1 to September 1, the activity of the queen in egg-laying will decrease and the amount of brood, even in a normal colony, will be very much less than at any time preceding the honey flow. Sometimes there will be almost no larvae nor eggs, and but very little sealed brood. The beginner will be inclined to think the queen is failing, when, as a matter of fact, she and her colony are pursuing a normal course. Nature evidently works on the plan that there is no use in producing a lot of worker bees and consumers when they can be of no possible help to the colony; so she husbands her forces until another honey flow comes on toward

Unsealed, partially sealed, and fully sealed honey, which may be in either worker or drone cells. Capillary attraction prevents the unsealed honey from running out.

fall. At that time brood-rearing will start up again, and possibly the hives may have as much brood as at any time during spring or early summer. But if cool or frosty nights come on, the amount, probably, will not go beyond one or two frames. If considerable brood is in the hive when a severe cool or cold spell comes on, it is apt to result in a lot of chilled brood.

Sometimes during the flow when late

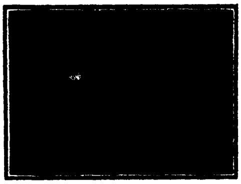


This shows an ordinary frame of sealed brood containing both drone and worker cells. The drone brood appears at the top and at the lower corners. The cappings are larger and much more convex than those of the ordinary worker cells. When comb is built from full sheets of foundation there is not much drone brood; but sometimes, when a colony is determined to rear it, they will enlarge the cells as they did in the case above. The unsealed brood is shown scattered here and there in the open cells, most of it worker, but a little of it drone. Some of the older brood had emerged, leaving here and there empty cells in which the queen will lay again. In the midst of a heavy honey flow these cells will be filled with honey. Sealed honey is shown in the upper corners; and the unsealed is shown just above the brood, and below the capped honey. The color of the cappings over honey is usually white, while over brood it is more fibrous and from a light to a dark brown.

flowers are in bloom the bees and queen apparently become excited and begin breeding heavily. A chilly, rainy spell may come on for four or five days, but not cold enough to kill the blossoms in the fields. During the interim the cluster contracts, especially at night. The young brood outside of the cluster chills and dies. In a day or two these larvae will be found scattered around the entrance of the hive, and the beginner is inclined to come to the conclusion that something is wrong—that some bee disease like foul-brood is in the hives. (See Diagnosing Colonies.)

The statement was made that egg-laying would begin to decrease after the main honey flow. This is true with all except young laying queens. A queen reared in June will probably continue laying all through the summer, and the colony will contain brood in all stages. One reared in September will begin laying immediately, no matter what the conditions, and she will keep it up till cool or cold weather shuts it off.

In some localities it is an advantage to use young queens in order that there may



Capped brood in lower left corner, pollen above and at the right.

be a large force of young bees for the honey flow that will follow the main one. The secondary flow, perhaps, will be from buckwheat, aster, goldenrod, or all of them. It is important to have a strong force of bees for it. Brood-rearing should, therefore, be continued from the first flow either by having young queens or by stimulative feeding, if honey is not coming in from natural sources. (See Feeding, subhead Feeding to Stimulate; also Building Up Colonies.)

"By Their Fruits Ye Shall Know Them"

The amount of brood and the manner in which the eggs are laid—whether in scattered or irregular patches—also give one a fair idea, even though he has not seen her, of the kind of queen he has in the hive. If there is only a scant amount of brood, and eggs are scattering when other colonies are well supplied, the presumption is that the queen is failing, and that a better queen should be put in her place. After she is found, the probabilites are that she will be small—not much larger than a worker.

If, on the other hand, brood is found in six or seven frames in the spring in all stages of growth from eggs to the emerging bees, in a ten-frame colony, the conclusion may be drawn that the queen is a good one, even though she has not been seen. "By their fruits ye shall know them." When located, the queen will probably be discovered to be large, handsome, long or full-bodied. By waiting a moment, one may have the pleasure of seeing her lay an egg, for such a queen is usually on the job night and day.

As already stated, after the main honey flow egg-laying may almost entirely cease. One is more apt to find this condition at the close of the main harvest where the queen is one or two years old. A young queen reared in spring will usually continue to lay throughout the season. But, as a rule, any queen will begin laying when new honey begins to come in or when the colony is given stimulative feeding. Brood-rearing late in the fall, when the general weather is such that bees can not fly, is not desirable, since it does more harm than good. There should be no brood in the hives during winter in the North until about February or March, and then only small patches and in outdoor colonies.

Very early brood-rearing during winter may or may not be a good omen. Much will depend on the climate and the winter. A mild winter or a mild climate will start breeding, especially if the bees can fly; but if a sharp cold snap follows, much of the brood will die, and the colony will suffer. In the South, on account of the mildness of the climate, brood-rearing may or may not progress every month in the year. Breeding always requires a large amount of stores, and this explains why bees in the southern states consume more stores during winter than those in the North.

Brood-rearing in the South

Bees in the South will have to gather from 200 to 250 pounds of honey for colony maintenance before they store any surplus. So much honey is consumed in constant brood-rearing and flying every day for 11 or 12 months that the bee-

keeper of the Southland should figure on at least two or three pounds of honey to maintain a colony to every pound he will get for surplus. In many instances the ratio would stand four to one. In the states farthest south some of the best beekeepers believe that during the winter their bees have to raise two or three families of brood before they can get one to gather the honey. That means that the hive will have to be filled with brood two or three times, each generation dying off before the third or fourth generation can gather the main honey crop.

On the other hand, northern bees, during the five or six months of winter, are in a semi-dormant state, during which they raise but little brood, consume very little stores, and last, but not least, require no attention.

Brood-rearing During Midwinter

Mention has been made that brood may be found in the hive during midwinter, particularly with bees outdoors. If the weather is mild, or if bees are located in a southern climate, brood may be found in the hive every month in the year. Ordinarily, in the northern states no brood will be found much before February; but breeding may be started either in the cellar or outdoors by giving slabs of hard candy laid flat on top of the brood-nest with two ⅜-inch cleats to hold it up from the top of the frames. (See Candy, particularly Hard Candy.) Disturbance of the brood-nest in or out of the cellar will also often start breeding. The average beginner would do well not to hasten things before the bees themselves commence. If brood-rearing begins too early there is danger of dysentery setting in. (See Dysentery.) In order to maintain brood-rearing, the temperature of the colony must be up to about blood heat—94° F. This stimulates the activities of the colony, causing a large consumption of stores; but if the bees are not able to make winter flights, the retention of the feces may cause dysentery. When this starts in January or February it will probably mean the loss of the colony before spring. (See Dysentery.) However, an experienced beekeeper in the northern states may start brood-rearing sometimes by giving slabs of candy, and the result will be that the colony will be stronger by spring than in the fall. But the average beginner should let the bees severely alone, provided he is certain they have plenty of stores and are well housed.

For a further discussion of brood and brood-rearing, see Feeding, subhead Feeding to Stimulate; Candy; Spreading Brood; Queens and Queen-rearing. For a discussion of brood diseases, chilled brood, and neglected brood, see Foulbrood.

Drone Brood

This has the general characteristics of worker brood, except that the cells are larger and the cappings more convex. While worker brood emerges in from 20 to 21 days from the laying of the egg, drone brood emerges in from 23 to 24 days. (See large half-tone plate.)

A drone-laying queen or a laying worker (see Laying Worker) may lay drone eggs in worker-cells. In that case the brood will be worker size, but the cappings will be more convex than ordinary worker.

Drone brood will often die from neglect. It will smell like foulbrood, but lack the characteristics of either European or American foulbrood. Beginners sometimes suppose it to be a disease. But dead drone brood usually means nothing serious, especially if the worker brood in the hive is normally healthy.

Amount of Honey Required for Brood-rearing

The amount of honey used by a colony of bees for its own maintenance is 200 to 300 pounds per year in the southern states. This is the amount the bees must gather before any surplus can be secured. While this amount may seem excessive, it is not so high as some estimates. The data which are available on this subject are meager, but they all indicate that surprisingly large quantities of honey are used by the bees during the active season.

Beekeepers have no means of knowing exactly how much it costs in honey for the bees to rear a given amount of brood, and one can only approximate the amount of honey used by adult bees when they are active, as during a honey flow. Some work done by R. L. Taylor in the Michigan Experimental Apiary in 1896 yielded figures indicating that four pounds of honey are used to produce a frame of brood of Langstroth size. These figures were obtained by carefully conducted experiments. M. T. Pritchard reports that, in his queen-rearing operations, he feeds his cell-building colonies, after the hon-

ey flow, one quart of sugar syrup made of two parts of water to one part of sugar, which is about the equivalent, in sugar content, of a pound of honey. This causes the bees to rear brood at the rate of five frames of brood every 20 days, these five frames being removed from the brood-chamber every 20 days and placed above a queen-excluder. Five combs every 20 days is at the rate of one comb every four days, to produce which he feeds the equivalent of four pounds of honey. If no nectar is coming in from the fields, these colonies use a small amount of their reserve stores in addition to the quart of thin syrup per day. These figures agree closely with Taylor's figures of four pounds of honey to produce a frame of brood.

In 1901 Adrian Getaz collected all of the data which had been published up to that time in American beekeeping literature on the subject of "feeding back" extracted honey for the completion of unfinished sections. These figures indicate that a colony of bees, when actively engaged in storing comb honey in sections, uses one and a half pounds of honey daily. In practically every recorded case brood-rearing was restricted, while the colonies were being fed, by reducing the brood-chamber to five combs. From this great mass of figures on feeding back Getaz concluded that 170 pounds of honey is the lowest amount consumed by a normal colony during the year.

Disregarding the brood reared previous to about April 1, and assuming that a colony rears two frames of brood during the first period of 21 days, five frames of brood during the second period of 21 days, and 10 frames of brood during the third period of 21 days, we have a total of 17 frames of brood, which, according to the above figures, cost 68 pounds of honey. Some colonies will probably produce 20 combs of brood in this time costing 80 pounds of honey. This takes the colony up to about the first of June. Assuming an average of five frames of brood through July and August, we have 15 frames of brood costing 60 pounds of honey. Assuming three frames of brood through August and September, we have nine frames of brood, or a total of 164 to 176 pounds for brood-rearing alone. To this must be added 15 to 20 pounds for winter and the amount of honey used by the adult bees when they are active during a honey flow. On this point we have but little information; but, if the foregoing figures are nearly correct, normal colonies of bees must consume more than 200 pounds of honey annually, even in the North.

The large amount of stores needed for brood-rearing during the spring, in some cases apparently as much as 80 pounds, emphasizes the need of close attention to stores during this time when bees may not be able to gather much from the fields.

Egg-Laying Capacity of a Good Queen

Various estimates have been made as to the number of eggs that a queen can lay in a day. These figures range all the way from seven or eight hundred to six thousand in a single day. While the last-named are probably high, the first certainly are low. For many years it has been believed that the maximum capacity of a good queen under favorable conditions would be about 3000 eggs in a single day, or perhaps an average of half that, covering a period of two or three weeks in the height of the brood-rearing season just before or during a part of the honey flow. Some work done by W. J. Nolan, of the Bureau of Entomology, and by Dr. J. H. Merrill, formerly of the Agricultural Experiment Station of Kansas, indicates that the daily average would not go above 1500 and the maximum figures not much above 1800. (See Bulletin by W. J. Nolan, No. 1349, U. S. Department of Agriculture, and article by Dr. J. H. Merrill, Gleanings in Bee Culture, page 452 for 1923.)

It should be noted that there is considerable difference between the actual capacity of a queen to lay a certain number of eggs and the number of eggs that will actually be developed into brood. For that reason, Nolan made his estimates upon the amount of sealed brood rather than upon the amount of both unsealed as well as sealed. The sealed brood would give a more accurate estimate of the numerical population that might reasonably be expected later on. Nolan found that the *effective* egg-laying would not go much above 2,000 eggs for the vicinity of Washington, D. C.

The fact that Nolan's and Merrill's work so nearly agree rather sets aside previous figures or estimates to the effect that the queen's effective egg-laying capacity was much higher, or betweeen 3,000 and 5,000.

If the reader will turn to the subject of Building Up Colonies and to Demareeing for the control of swarming, it will be seen that it would be possible to increase the amount of brood by manipulation of the brood-chambers. In the author's apiaries, the food-chamber method was used and then the brood-chambers of the colony itself were alternated from time to time, as explained under those heads. (See also Food-chamber.)

As will be pointed out further on, the eggs will not hatch unless they are supplied with larval food by the nurse bees just before the larva breaks the egg case surrounding it, and if this food is not so placed, eggs will never hatch. Unless the weather is warm, colonies populous, and unless likewise there is a large amount of natural stores, or nectar coming in, large numbers of eggs will not hatch. Without a maximum number of bees of the right age to go to the field, the actual crop of honey secured will be far short of what it should be. All through this work emphasis will be placed upon the importance of protection, plenty of natural stores and the colony sufficiently strong so that it can take care of the eggs and the brood later on.

How the Birth Rate and Death Rate Vary During the Season

During the height of brood-rearing in the spring the death rate is very much lower than the birth rate. In other words, in the early part of the season and just before the honey flow, the strength of the colony increases very rapidly. *After* the crop has been secured, the death rate is very much more rapid than the birth rate. The queen either lets up on her egg-laying or stops altogether. In the meantime, the old bees that have toiled during the season with worn-out wings die by the many thousands in the fields and never come back into the hive.

The author has repeatedly noticed that colonies of four and five story size will dwindle down during the latter part of the season in the vicinity of Medina, Ohio, to a one-story colony. If there is a fall honey flow, the queen may start brood-rearing again with the result that the birth rate will exceed the death rate. As a rule, the old queens after they have toiled a season will diminish their egg-laying or stop altogether after the main flow. If the old queen is replaced and a young one put in the hive, she will begin egg-laying again with the result that a large force of young bees will be added to the colony. (See Brood Curve under Building Up Colonies.)

The Development of Brood

Some very interesting work has been done in the study of the development of brood, notably by Bertholf, Lineburg, Sturdevant, and Nelson. They were formerly connected with the Bee Culture Laboratory of the Bureau of Entomology, Washington, D. C. The development of the larva as it grows from day to day, and its movements in the spinning of its cocoon, have been observed through cells having glass sides. While it will not be possible to tell the whole story here, some things can be shown that will be helpful and useful to the student as well as the one who is earning his living from the bees.

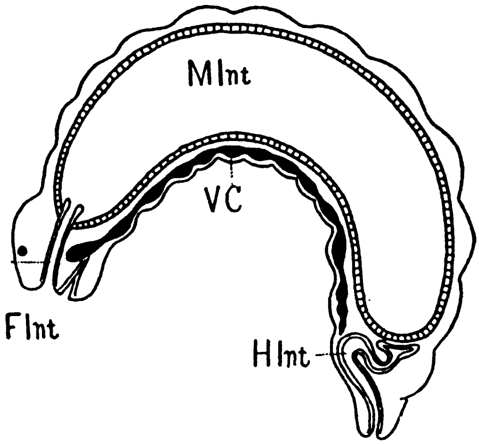


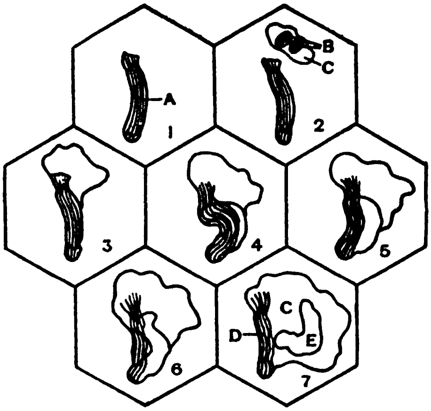
Diagram of a longitudinal section through a larva. FInt, fore intestine; HInt, hind intestine; MInt, mid intestine; VC, ventral nerve cord. From "Beekeeping," by E. F. Phillips.

We will first start with the egg. Instead of having a hard shell, the outer covering is soft and membraneous.

It is quite interesting to watch the queen in her egg-laying. One would naturally suppose (if it is possible, for example, for her to lay 2000 eggs in a day) that she would have to move much more rapidly and lay faster than she really does. On the contrary, her movements are very deliberate as she moves among her throng of busy workers; and when she deposits the egg in the cell, she seems to be in no hurry. But in view of the fact that she works long hours with short intervals of rest, she is able to accomplish a large amount of work.

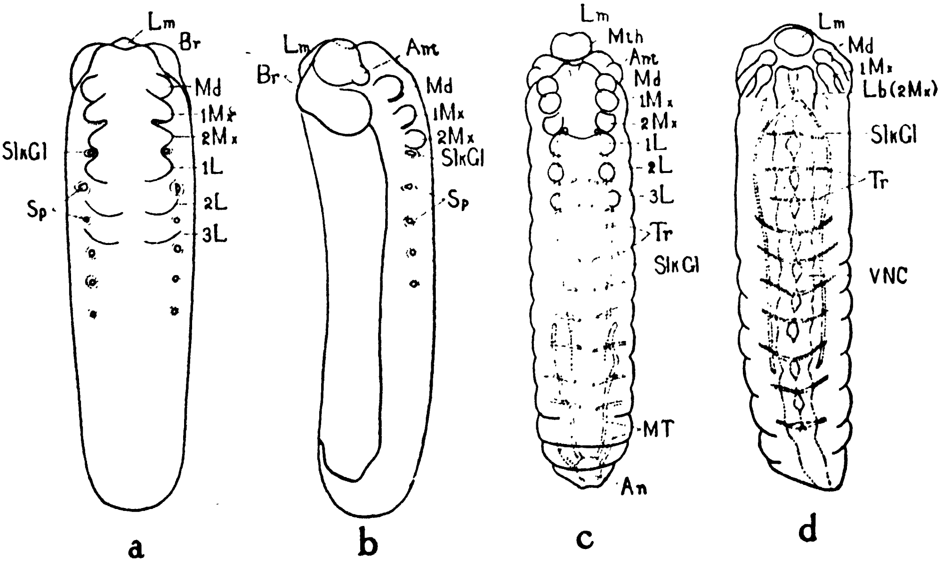
Let us watch her for a few minutes.

If she is given an empty comb, which the nurse bees have cleaned out and made ready for her, she will lay pretty rapidly, taking one cell after another. But as already pointed out, some of these eggs may not hatch. As the brood begins to develop, later on she apparently checks up on her work. She will go all over the brood hunting out here and there the stray cells which contain no eggs or brood. She will deliberately examine each of those cells one at a time. After having picked out her cell, in spite of all the jostling and crowding on the part of her busy throng of workers, she will circle about and finally push her abdomen down into the precise cell she has just examined. She then crouches deliberately down with her legs on the sides of the other cells and her wings out behind till she reaches the bottom; remains there from ten to fifteen seconds; she then pulls herself out, walks deliberately over and inspects another cell and then repeats the operation. In each case it will be noticed that the egg is deposited in the base of the cell, the egg standing out at right angles and parallel with the sides of the cell itself. The egg will hold itself in this position until within a few hours of hatching. It will then be observed that the egg case, or what might



Sketches showing first feeding and the hatching of a honeybee larva as seen through the glass base of a cell. A, egg (larva inside egg-case); B, mandiblas of feeding bee; C, larval food; D, egg-case; E, larva. In sketch No. 4 the larva has just burst the egg-case. Sketch No. 7 shows the larva lying on the bottom of the cell surrounded by food and free from the egg-case. The larva and the larval food are enlarged to a much greater extent than the base of the cell.

be called the shell, becomes more transparent and the larva ready to hatch can be seen within. See below. Just about this time the egg will assume another angle. It will lie flat in the bottom of the cell. About this time the worker bees that have been poking their heads into the



Three stages to development of the egg (greatly magnified). The earliest stage at which the rudiments of the appendages are seen is represented by a and b; a, egg seen from the ventral (lower) side; b, from the right side; c, later stage, showing the development of the mouth parts, silk glands, etc.; d, embryo just prior to hatching, the development within the egg being completed; An, anus; Ant, antenna; Br, brain; 1L, 2L, 3L, thoracic legs; Lb, labium (lower lip); Lm, labrum (upper lip); Md, mandible; MT, malpighian tubules; 1Mx, 2Mx, first and second [illegible]e; SlkGl, silk gland; Sp, rudiment of spiracle; Tr, trachea; VNC, ventral nerve cord.

cells from time to time evidently to determine the growth of the larva within will deposit a very small amount of larval food at a point just above the attachment of the egg. The egg will not hatch until this food runs down upon the egg and then the little life within bursts the shell, or egg case, shortly after the larva curls up like the letter "c," the two ends meeting. The nurse bees continue to add more larval food and the little grub wriggles around in the form of a circle. It continues to grow until it fills the bottom of the cell. As it gets a little larger, it straightens out lengthwise of the cell, moves back and forth, changing from end to end, and finally when it has filled the cell completely, it turns its head toward the opening and remains motionless, taking no food from that time on until the

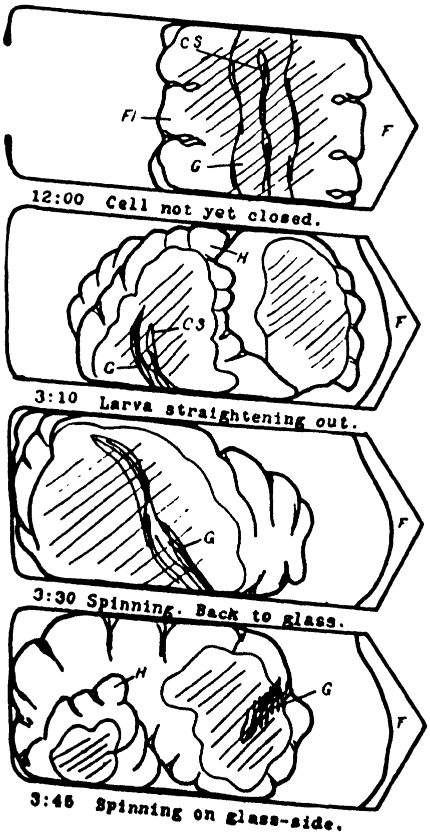


PLATE I.
Sketches made on July 19 to show movements of honeybee larvae. Sketch at 12:00 N. shows full-grown larva with its back pressed tightly against the cell walls. CS, circulatory system; F, food in bottom of cell; Fl, fold on side of body; G intestine; H. head.

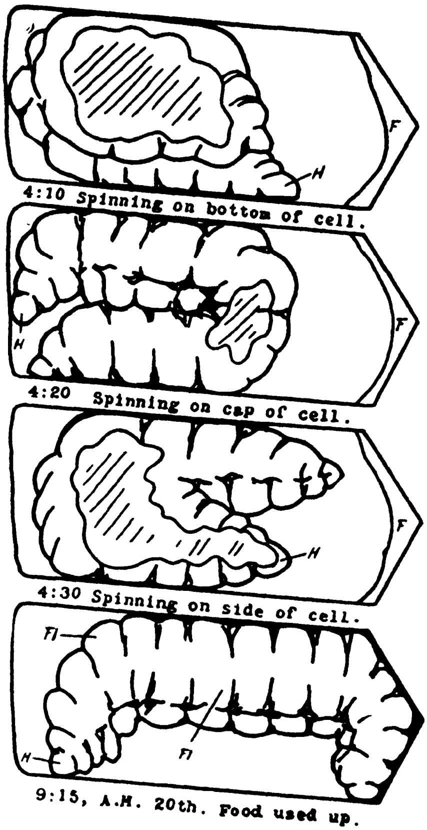


PLATE II.
Sketches made July 19 and 20 to show positions of larvae in spinning on bottom, sides and ends of cell. H, head; F. food; Fl, folds on back and sides. It requires 11 minutes on the average for the larva to move from one end of the cell to the other end.

young bee emerges by cutting off the capping. During its development the honeybee molts or sheds its skin five times during its larval life and once more shortly before it emerges as an adult from its cell, according to Dr. L. Bertholf, a former employee of the Bureau of Entomology. (See Journal of Economic Entomology for April, 1925, pages 381-384.) The various stages of growth can be seen in the illustration here shown.

It should be remembered that there are three stages of brood, the egg, the larva, and finally the pupa.

A study of the movements of the larva up to the time it becomes motionless, lying as still as death, is very interestingly shown by Lineburg in the accompanying drawings taken with the camera lucida.

A careful study of these drawings in connection with the legends beneath will show the precise movements of the larva.

Mr. Lineburg in his very interesting article for Gleanings, June, 1924, page 356, has this to say of the movements of the larvae:

How Larval Food is Supplied

Royal jelly is supplied directly by the month and not through the proboscis. During the first days of larval life this food is placed in the cell beside the larva. The food is not placed within the circle which the larva makes as it moves around and around within the cell, but it is placed at the border of the mass of food already present. The young larva, accordingly, is surrounded by a mass of food, as previously stated. At first, this food covers only a portion of the bottom of the cell. Later this mass is increased in size until the whole bottom of the cell is covered with food. After several days food may be placed within the ring formed by the body of the well-developed larva as well as on the sides of the cell outside this ring.

Returning now to a consideration of the feeding conditions on the first day of larval life, it must be remembered that, although the food present in the cell is about four times the size of the larva, the mass of food is in reality but little larger than the head of a pin. If cells containing larvae of this age are covered with wire cloth so as to exclude the nurse bees, it will be found that evaporation within the hive is so great that within a few minutes a thin crust is formed over the surface of these minute quantities of food. Within an hour or two the whole mass is reduced to a tough jelly-like substance in which the larva is utterly helpless either to move or to feed. Such observations must be made under the microscope.

How Larval Food is Kept Moist

Under normal conditions the nurse bees prevent the drying out of the food. This they do by supplying the fresh food frequently. In fact, nurse-bees have been seen to visit day-old larvae on an average of once every two minutes. Not all of these visits are made for the purpose of feeding. When food is given, it is placed on the border of the mass already present. The nurse-bees apparently seek to avoid actual contact with the larva.

With these facts in mind it is possible to understand the importance of the circular movement of the larva. By this movement the larva not only brings itself frequently into contact with the fresh supply of food wherever it is added, but the movement itself serves constantly to mix the old supply with the new, and thus keep the entire mass at all times moist and in a condition suitable for ingestion. The movement continues throughout larval life except for periods of rest. It is this same movement which enables the larva to straighten out in the cell and also to move about while spinning its cocoon.

The Method of Movement

As is well known to students of entomology, the honeybee larva has no legs. It is therefore unable to crawl as most insect larvae do. In fact, if a young larva is placed on a glass slide with a mass of food just in front of its head or even touching its head, it is unable to move forward the distance of its own length. It perishes accordingly because it is unable to regain a position where it is surrounded by a mass of suitable food. A full-grown larva, likewise, is utterly helpless when placed upon a flat dry surface, but under its natural conditions it probably moves 150 times from end to end of its cell while spinning its cocoon.

The method of movement is probably the same in both the young and fully developed larva. In the fully developed larva this activity appears to be due largely or wholly to a peculiar use of the heavy folds which are conspicuous on its sides and back. These folds are retracted and later protruded again in a more advanced position. The movement somewhat resembles the crawling of a caterpillar, if one can imagine each of the caterpillar's legs to disappear into the body when not actually aiding in the support of the body, the legs appearing again in a more advanced position instead of the usual caterpillar method of raising the leg and moving it forward. Doubtless, these movements of the larva are an aid in its breathing and to the circulation of its blood much as muscular activities are in the case of our own bodies.

When the hatching larva frees itself from the egg case, it forms a small semi-circle with its back on the outer circumference. As it grows, it occupies more and more space until its back is pressed tightly against the walls of the cell. Continued growth produces still greater distortion until finally all semblance to the larval shape is lost, and the larva appears as a six-sided plug which fills considerably more than half of the cell.

Because of the extremely compressed condition of the full-grown larva, not only its back but a considerable portion of its sides are actually in contact with the walls of the cell. It

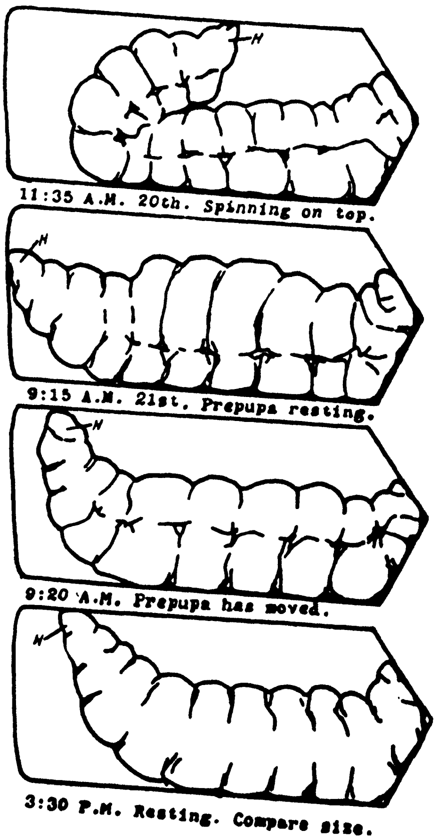


PLATE III.

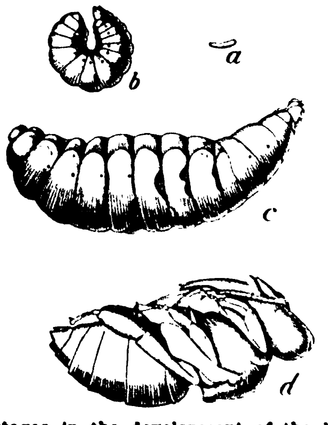
Sketches made July 20 and 21 to show movements of the larva and of the prepupa or pronymph. The sketch at 9:15 shows the prepupa turned slightly on its side. The other sketches show the normal position, that is, flat on its back.

appears, therefore, that any creeping movement which is produced must be accomplished by these parts of the body. Such is actually the case. The folds of the back and sides act as locomotor appendages in the manner previously described.

To straighten itself out, the fully developed larva curled in the bottom of the cell simply turns its head slightly toward the cap of the cell, and the same movement which carried it around in the bottom of the cell now serves to lengthen it out into a short spiral coil (see illustrations). This same movement likewise enables it to reverse its direction readily within the cell while spinning its cocoon.

When the work of spinning its cocoon is finally finished, the larva turns its head toward the cap of the cell and stretches out for a long rest. Stretched out thus, it passes through the various stages of pronymph, pupa, and finally reaches the adult stage. Not until this stage is reached does the creature turn over on its ventral side, thus removing its back from the walls of the cell.

After sealing, the larva begins to change into three segments. The rudiments of mouth parts, compound eyes, legs, and wings begin to form. Development goes on until a perfect white bee is seen. The large compound eyes turn pink; the body turns darker. Later the eyes turn to brown and then to black, and in the meantime the body turns to the natural color and markings. All of these wonderful changes can be seen by cutting off the cappings of the sealed brood at different stages of growth.



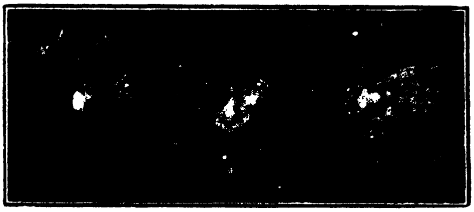
Four stages in the development of the honeybee: a, egg; b, young larva; c, old larva; d, pupa. From "Beekeeping," by E. F. Phillips.

For further particulars refer to article by Bruce Lineburg in Gleanings in Bee Culture, page 18, 1925, Bulletin No. 1222, U. S. Department of Agriculture by Nelson, Sturdevant and Lineburg; also to Dr. Jas. A. Nelson's book, "The Embryology of the Honey Bee." This is the most complete of anything that has ever been published. See also his paper, "Morphology of the Honey Bee Larva," reprinted from Journal of Agricultural Research, June 21, 1924.

Young Bees After They Emerge

The young bee, when it gnaws its way out of the cell, commences to rub its own nose, straighten out its feathers, and then push its way among the busy throng, doubtless rejoicing to become one of that vast commonwealth. Nobody says a word, nor, apparently, takes any notice of the youngster. If a colony is kept without young bees for a time, one will see a new energy infused into all hands just as soon as young bees begin to gnaw out.

If one should vary the experiment by



Bees gnawing through the cappings and emerging from their cells.

putting a frame of Italian eggs into a colony of black bees, he will be better able to follow the newly emerged young bee as it matures. The first day it does little but crawl around; but about the next day it will be found dipping greedily into the cells of unsealed honey. After about the first day it will begin to look after the wants of the unsealed larvae, and very soon assists in furnishing the milky food for them. While so doing, a large amount of pollen is used, and it is supposed that this larval food is pollen and honey, partially digested by these young nurses. Bees of this age or a little older supply royal jelly for the queen-cells, which is the same, probably, as the food given very small larvae. Three days before they are sealed, larvae to produce worker bees and drones are fed on a coarser, less perfectly digested mixture of honey and pollen. Young bees have a white downy look until they are a full week old, and continue a peculiar young aspect until they are quite two weeks old. At about this latter age they are generally active comb-builders of the hive. When a week or ten days old they take their first flight out of doors. There is no prettier sight in the apiary than a host of young Italians taking a playflight in the open air in front of their hive.

Their antics and gambols remind one of a lot of young lambs at play. (See Playflights. For a discussion of the first duties of young bees, see Age of Bees.)

BROOD, SPREADING. — See Spreading Brood.

BUCKWHEAT.—The plant is dimorphic; that is, there are two forms of flowers, one with long stamens and short styles and the other with short stamens and long styles. This arrangement promotes cross-pollination. In the long-stamened flowers most visitors touch the anthers with the under side of the body and the stigmas with the head; and the converse takes place in the short-stamened flowers. Each plant bears flowers of one form only, but the seed from either form will produce both forms in about equal numbers.

When the flowers are legitimately pollinated—that is, when pollen is brought from flowers with short stamens to flowers with short styles, or from flowers with long stamens to flowers with long styles —the seeds are more numerous and heavier than when the flowers are pollinated illegitimately. The pollens of the two different forms of flowers differ in size and each is less active upon its own stigma than upon the stigma of a flower of the other form, or it may be entirely inactive (impotent) upon all flowers of the same form as the flower producing it. Thus the functions of the flowers are such that the advantages of cross-pollination are secured, and yet every flower may produce seed. The flowers of buckwheat, according to Darwin, possess the power of self-fertilization; but early in the season, if covered with nets, they are almost wholly self-sterile and produce hardly any seed. Flowers cross-pollinated artificially at the same time produce seeds in abundance. Later in the season, during September, both forms of flowers become highly self-sterile. They do not, however, produce as many seeds as some neighboring uncovered plants which are visited by insects. Thus the crop of seed is largely dependent on insects, chiefly honeybees, which are estimated to make ninetenths of the visits.

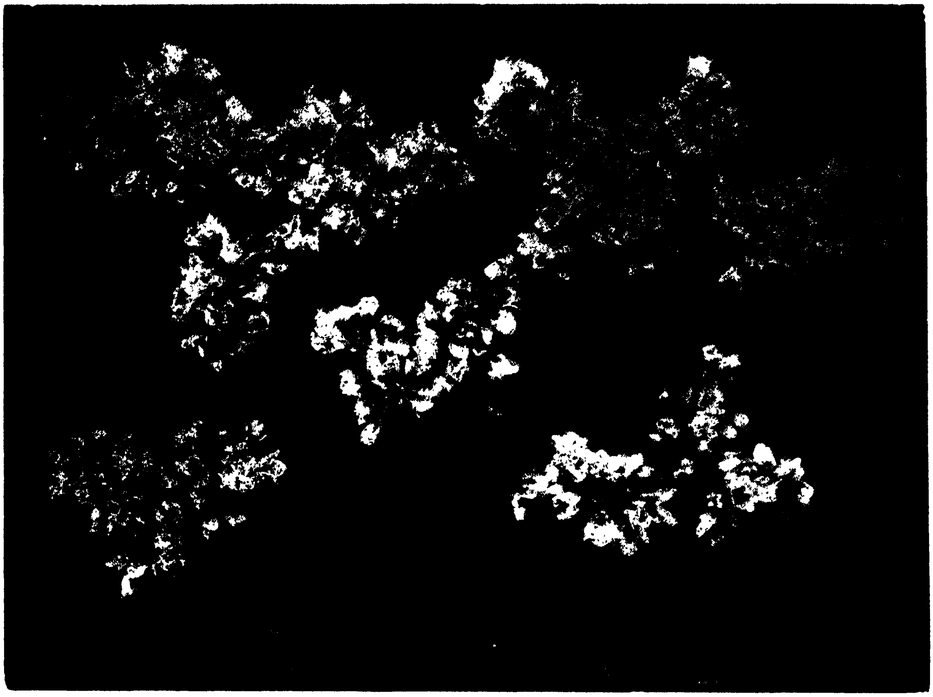
Buckwheat as a Honey Plant

Buckwheat can be cultivated throughout the North Temperate Zone. It is extensively grown in Asia, especially in Japan, and is also widely cultivated in Europe. An immense quantity of buckwheat honey is gathered in Russia. In North America, while it is grown to some extent in Canada, it is chiefly valuable for grain in the United States. It is best adapted to New York, Pennyslvania, Ohio, Michigan, Wisconsin, and New England, and to the mountainous sections of Maryland, West Virginia, Kentucky, North Carolina, and Tennessee. About two-thirds of the crop is now raised in New York and Pennsylvania.

The flowers of buckwheat secrete nectar only in the morning; toward noon the flow lessens and ceases entirely during the afternoon, but begins again vigorously the next morning. The visits of the bees quickly decrease in number until they cease almost entirely, and they remain idle about the hives for the balance of the day. Thus in the afternoon, notwithstanding the great expanse of bloom and its strong fragrance, only a few bees can be found in the fields.

In New York buckwheat can be depended upon almost every year to yield a crop of honey, but in the West it is more uncertain, some years yielding no honey and in others a fair amount. In Ohio the yield of nectar from buckwheat is so irregular and scanty that there is seldom a season that much honey is obtained from it. Since in the East it is almost always very reliable, when even basswood and clover fail, as they do sometimes in every locality, the beekeeper is usually able to make his expenses and a fair profit. In New York it is seldom that he is not able to make a fair living from buckwheat alone.

Among cultivated crops there are few which will afford a better artificial honey-pasture than buckwheat. The beekeeper who raises this cereal largely for honey should plant at three different times in order to prolong as much as possible the flow of nectar. On an average it will occupy the land a little over 60 days. It will commence to yield nectar in 15 or 20 days from the time it is planted, and takes about 10 days to mature after the honey flow ceases. If the first crop is sown on the 20th of June, the second crop on the 4th of July, and the third about the 18th of July, the beekeeper will be assured of a good bee-pasturage from the middle of July, when basswood and clover are past, to the middle of Septem-



Honey for the bees, seed for harvest, fertilizer for the ground — buckwheat should be planted extensively.

ber, when the fall wild flowers begin to bloom.

Buckwheat seed may sometimes be given away profitably to farmers in localities where this grain is not grown. By furnishing the seed free for one or two years farmers may perhaps be induced to grow this crop regularly in after years. It is not advisable to give the seed after the second year; during the third and the fourth years it should be furnished at half-price. It should not be supplied free to any one living more than a quarter of a mile from the bees.

Buckwheat Honey

Buckwheat honey is of a dark-purplish color, and looks much like the old New Orleans or sorghum molasses. The flavor, to one who is a lover of clover and basswood honey and is unaccustomed to that of buckwheat, is somewhat strong; but those who have always eaten buckwheat honey, or at least many of them, prefer it even to clover or basswood.

A lady from the East once called at a store and looked over the honey. She was shown several samples of choice clover and basswood honey.

"I do not like this," she said. "It looks like manufactured sugar honey. Haven't you any buckwheat honey?"

"Yes, but we did not suppose that you would like that, because such honey rarely sells in our locality."

Some sections of buckwheat honey were placed before her and these suited her exactly.

"That is real bee honey," said she, with a look of satisfaction, and she carried home several sections.

Her father had been a beekeeper in a locality where buckwheat was abundant; and unless honey had the strong flavor and dark color of the honey with which she was familiar in her childhood days it was not honey to her. There are thousands like her in the East who prefer buckwheat honey; and this trade is so large in New York and Albany that it brings almost as high a price as the fancy grades of white. But in the western markets, principally in Chicago, it is without purchasers and sells as an off-grade honey.

Notwithstanding the color of extracted buckwheat honey is purplish, the comb

A field of buckwheat in full bloom.

A small inexpensive extracting-room as formerly used by E. W. Alexander, of Delanson, N. Y. There are two openings in the end of the building that close with sliding doors. The full combs are put in through one door, and the empty ones taken out the other one. A pipe conveys the honey from the extractor to a tank in another building down the hill.

honey is very attractive, since the cappings, especially if made by black bees, are almost pearly white.

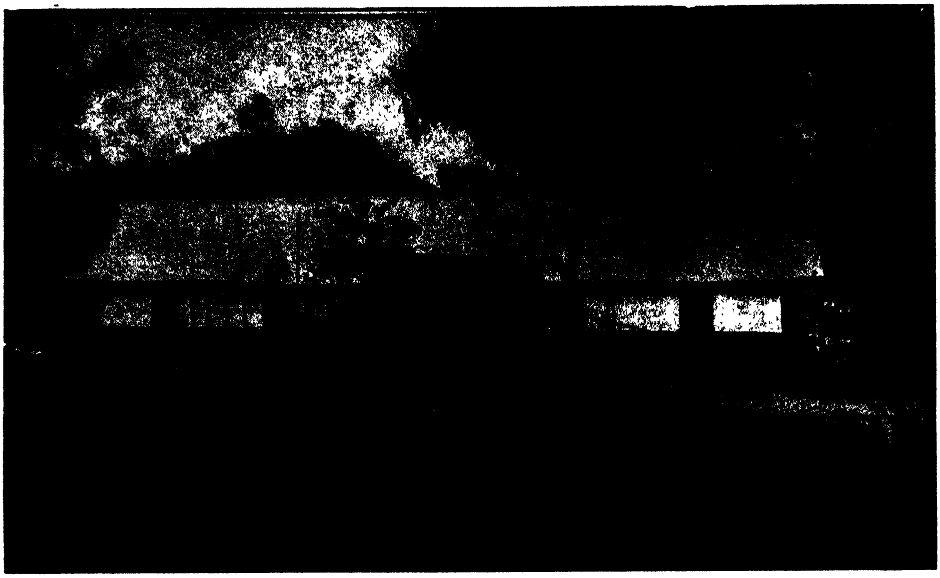
Buckwheat honey occasionally contains 33 per cent of water and is, therefore, too thin, according to the formula of the National Pure Food Law passed June 30, 1906, which limits the amount of water in honey to 25 per cent. It is thus necessary to evaporate thin honey in order that it may conform to the law. This may be done by means of a honey evaporator, or by storing it for a while in a hot dry room. The quality of the honey is so greatly improved that it will fully compensate for the trouble involved.

Varieties

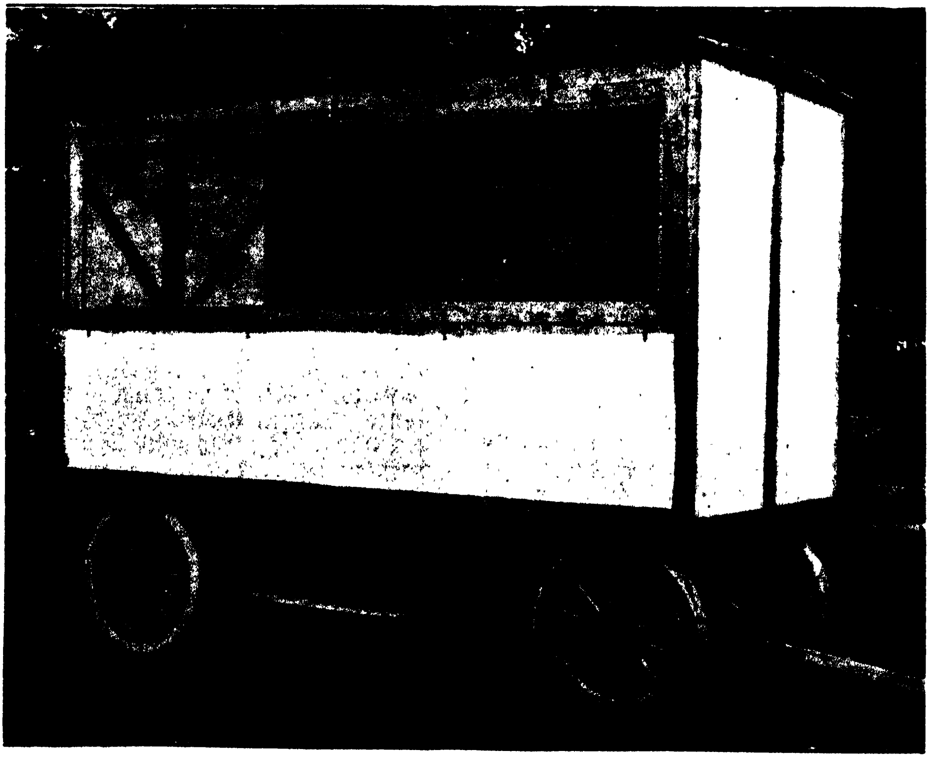
Three varieties of buckwheat are commonly grown in the United States—the Japanese, Silver Hull, and Common Gray, the last two being best for honey. Japanese has a large dark-colored seed, while Silver Hull has a smaller seed, glossy or silvery in appearance. The plant of the Japanese variety has a larger stalk, and the flowers do not blast so readily from heat; but it is believed not to yield nectar as freely as the other two varieties.

Information in regard to the culture of buckwheat has been furnished by C. E. Leightly of the Department of Agriculture, Washington, D. C. Other articles on buckwheat culture will be found in "The Cereals in America," by Hunt, and "The Small Grains," by Carleton.

BUILDINGS.—It is manifestly impossible to recommend any standard design of buildings for beekeepers' use that would suit all requirements. Some beekeepers require a room that can be used for extracting only; others several rooms for workshop, storage room, and extracting. The same room may often be used for different purposes at different times of the year. However, the purpose for which the building is to be used principally should be taken into consideration when it is planned. Much will depend on whether the structure is for all purposes and permanently located at home, or in



An inexpensive and quickly constructed building that answers every requirement. Walls and floor of wood, roof of canvas. A good canvas roof gives a better light inside and is cooler than a solid roof.



Canvas extracting-room built over an old touring-car converted into a trailer. There are two floors made of 1½-inch lumber, the lower one just the size of the frame of the chassis, and the upper one, 12 inches higher is 6 feet wide. The space between may be used for carrying supers, supplies, etc.

temporary and portable to be used at out-yards. The latter type of building will be described first.

The construction and materials for these buildings vary greatly from the light framework covered with canvas to the more substantial structures. Except the buildings erected at home apiaries, temporary or demountable, or "take-down-able" buildings are the rule for the reason that out-apiaries often have to be moved about.

Some use small buildings that can be easily loaded on a low wagon and hauled about from place to place. Still others use buildings made in sections bolted together, so that the various sections may be taken apart and loaded on a wagon in the flat.

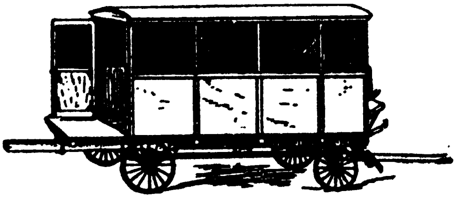
In locating a building, the place most convenient to the apiary must be taken into consideration; but if the lay of the ground permits, a downhill grade to the building makes it much easier to wheel or cart stuff to the building, and to let the honey run by gravity to a still lower level.

When there is no sidehill and the "gravity plan" is impractical a honey-pump is a real necessity to elevate the honey so that heavy lifting and consequent loss of time are avoided. (See Extracting.) In hilly or mountainous countries, however, there is no difficulty in selecting a sidehill. If desired, as is the custom in many parts of California, large honey-tanks may be located out of doors on the lower side of the building, the honey running from the extracting-room direct to the tank.

E. W. Alexander, of Delanson, N. Y., a beekeeper who had 750 colonies, all in one apiary, used for many years an extracting-house just large enough to receive an extractor, uncapping-box, and space to receive and pass out combs through openings in the side of the building, ordinarily covered with sliding doors. A tin pipe conveyed the honey by gravity to a large tank in another building on lower ground.

Extracting-houses on Wheels

There are many ingenious portable extracting-rooms consisting of a canvas or screen-covered framework on an extended wagon-bed. W. D. Jefferson, of Safford, Arizona, uses a low wagon with small wide-tired wheels. The platform is wide enough to extend out even with the outer edges of the wheels and long enough to give sufficient room for extracting purposes. Under the platform is a shallow tank, hanging between the front and rear



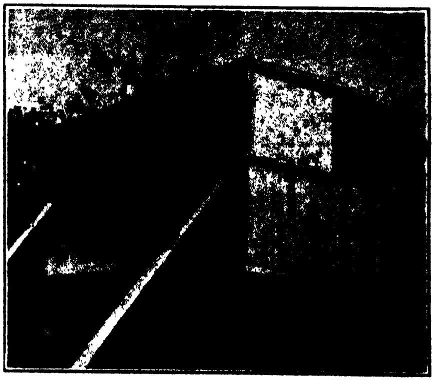
Jefferson's portable extracting-house. A 200-gallon honey-tank is located under the floor between the axles.

axles, which holds 200 gallons. The screen for the honey is in the floor over the tank where it can be changed easily as often as it becomes clogged. The honey, of course, runs from the extractor on to the screen and then into the tank.

This portable outfit is hauled from yard to yard, and the honey as fast as extracted is hauled home so that none of it is left at the outyard.

Automobile Extracting-house

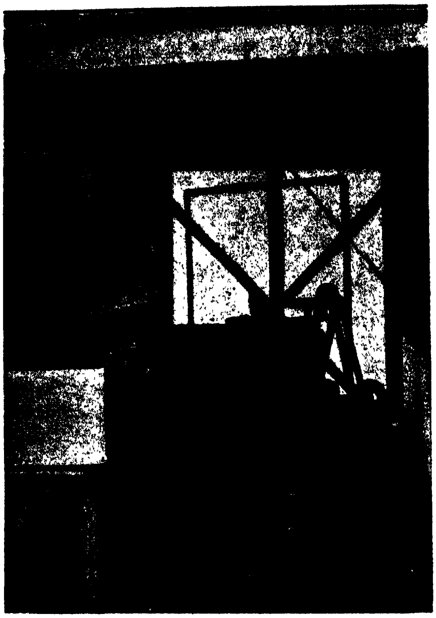
For an extracting-house that may be easily moved from one apiary to another, the running gear of an old discarded out-of-date touring car can often be used to very good advantage, with a superstruc-



Portable extracting house used by A. K. Whitten, Pala, California. Braces hold house steady.

ture similar to that of the Jefferson outfit. These old automobiles can usually be bought for little more than scrap price—anywhere from $5 to $10. If there are no tires on the machine already, second-hand ones can be secured at a moderate price. The whole outfit will not have to make any considerable mileage—only short distances to outyards. Cheap tires that have seen their best days will answer

a good purpose for an extracting-trailer. The illustrations, pages 124 and 125, show an outfit the author has used with considerable satisfaction. The superstructure consists of two floors, one resting directly



Interior of the extracting-room on wheels. The capping-box stands near the front on the left. The empty space at the right is for the supers.

upon the channel frame of the machine, and the other on two by twelve joists to clear the wheels. The lower floor is to hold tools, containers, and other equipment for general extracting.

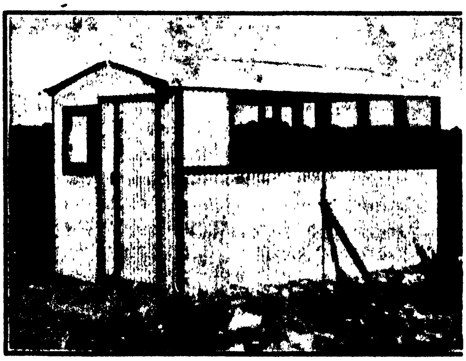
The room on top is made in six parts or panels held together by hooks. The two sides are screened so they can be opened, while the rest of the panels are made of canvas. The extracting engine and uncapping-box are arranged with the greatest economy of floor space, so that the operator will have plenty of room for uncapping and extracting. The honey is pumped from the extractor into a receiving tank. From here it is drawn by gravity into square tin cans by a pipe passing through the floor.

After the extracting season is over, the equipment, together with the superstructure, can be removed, leaving a first-class trailer that can be hitched to an automobile or horse-drawn wagon, and this trailer can be used for carrying any kind of loads, and will be specially serviceable in moving a whole apiary from one yard to another. If the roads are not too hilly, a Ford or other light machine will pull this trailer around very easily.

Ventilation and Windows

A common fault of beekeepers' buildings is that the ceilings are too low, affording inadequate ventilation, so that the temperature on a hot day becomes almost unbearable. A ceiling three or four feet higher than it would actually have to be adds but very little to the cost and at the same time permits a wide shelf, perhaps seven feet from the floor, running the entire length of both sides of the building. Such shelves not only help to keep the room cooler, but furnish much additional space for temporary storage.

For light and ventilation a very good plan is to cut out long horizontal windows in each side and perhaps in one end also, having hinged wooden shutters which can be lowered to keep out the storm in bad weather. A tight-fitting frame covered with galvanized wire cloth makes the opening bee-tight. There should be one or two glass windows as well to permit interior work in stormy weather when it would be best to have the shutters closed. All screened openings should be provided with several honey-house bee-



This dismountable extracting house used by H. A. Stearns of Duarte, California, differs from the others in that it is made of corrugated metal. It is very neat and well designed and should last indefinitely. The roof is covered with canvas.

escapes at the top to let out bees that are sure to get inside during extracting time. A screened door is a positive disadvantage, for the bees keep hovering around the door, and when it is opened many of them get in. A solid door or one

having glass in the upper part is to be preferred.

During a time when robbers are bad, allowing the bees to escape to the outside as fast as they get in the room is bad practice. A number of large beekeepers, instead of using bee-escapes, have the window screens removable or hinged at the bottom. The bees collect on the screens during the day; and after the work is finished, or late in the afternoon, the screens are removed or swung out at the top so that all the bees escape at once to their hives. The building thus acts as a robber-trap until the bees are released when flying is nearly over for the day. By morning the excitement will be over.

Portable extracting-house of A. F. Tice, Los Angeles. This structure is made up of door panels held together by clamps and bolts. The fact that Mr. Tice is a carpenter and builder explains why it is so neat and well designed. It is one of the best portable dismountable extracting-houses in California.

C. F. Hochstein, of Cuba, leaves an opening three feet wide all around his building. This he covers with heavy galvanized wire cloth. Ingeniously made bee-escapes constructed of wedge-shaped blocks of wood between the wire cloth and the siding are located along the upper edge. For a tropical climate this construction is all right, but in other localities smaller openings which can be entirely closed by means of hinged shutters are to be preferred. All honey-house bee-escapes which operate on the "cone" principle ought to be so constructed that the openings can be entirely closed in case the bees should get to robbing and should find the small exits.

One Large Central Extracting-plant versus Small Extracting-plant at Each Out-apiary

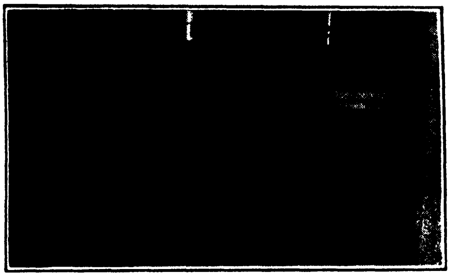
The equipment for extensive commercial extracting must necessarily be much more elaborate than that for the small beekeepers, although the principles are the same. The extractors, uncapping outfits and extracting outfits must be much larger.

We have shown thus far the various forms of small buildings used for general bee work and especially for extracting at the outyard. In each of these buildings there is usually a small hand

General view of Mr. Hiltner's honey house. The load of filled supers is driven into the building through the large door when the floor of the truck is on the level of the loading platform. The extracting room is at the right. The unloading platform is shown in the next cut.

extractor, an uncapping outfit, storage tank, and everything necessary on a small scale to extract the honey from the colonies at that particular yard.

It is coming to be more and more the

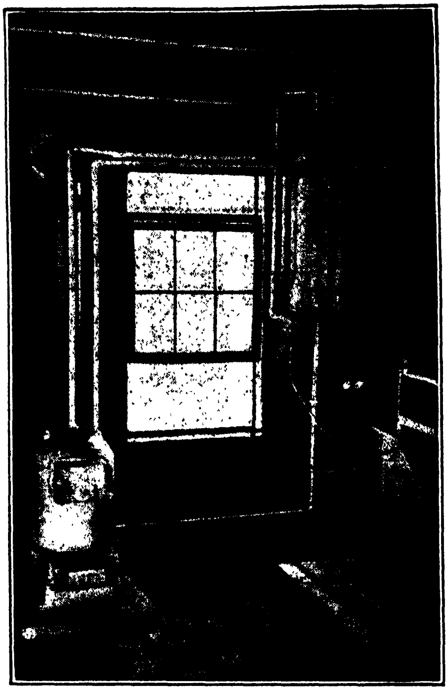


The loading platform is on a level with the floor of the extracting room, also on same level with floor or truck or trailer. Note the platform on castors for sliding piles of supers from truck to extractor.

common practice to put up one large central extracting-plant, usually at home, consisting of a substantial building more of the Hiltner sort, with power extractor and a complete extracting equipment in proportion. (See Extracting.)

Such a building is useful for a great variety of other work during different times of the year, especially during the winter when hives and supers can be nailed and painted, sections folded, frames nailed up, and foundation put in.

It is customary to have a little stove



The little boiler supplies both hot water for the capping melter and steam for the uncapper. The tank at the right acts as a steam dome for the boiler. (See Power Uncapper under Extracting.)

in at least one room of the building where one can work in comfort during the winter time. (By studying these different

A turn table with inverted cone bottom is mounted between the uncapper and the extractor to receive the combs as the operator uncaps them while the extractor is whirling the previous batch.

The operator has just finished uncapping enough combs to fill the turntable which also just fills the extractor. The drip from the combs on the turntable drains into the hollow shaft at the center, thence to the honey pump.

types of buildings one can get a fair idea of how to design his own building for his particular use.

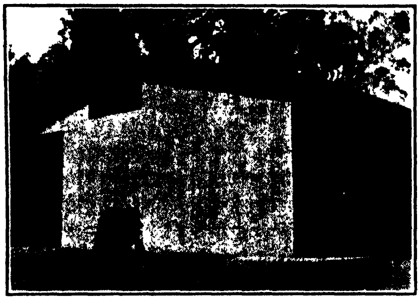
The central extracting-plant has the advantage that its total cost is less than the total cost of a number of small buildings with a complete extracting-outfit for each yard. If all the out-yards are located on good roads, or near good roads, as they should be, the problem of transporting the combs to the central extracting-plant is very easily solved with a small automobile truck that can be obtained for a few hundred dollars. In the old days when the roads were bad, when a horse and buggy or a team and wagon were the only means of going to and from the yards the individual extracting-outfits at each yard were cheaper from the standpoint of labor than the central plant; but present conditions are so radically different from what they were a few years ago that the central plant is much to be preferred, unless perchance one should be lo-

Two radial extractors run by one shaft with a clutch between. In this case the one extractor is running while the other one out of gear receives the uncapped combs.

cated where there are no good roads and the distances to the outyards great.

With a central extracting-plant one can take the combs out of the hives, load them into the truck, transport them to the central plant, extract and return them to the outyard at a minimum of cost and time. There will be no robbing at the out-yard because there will be nothing to attract robber bees. The honey that is extracted will be put into a large tank and kept under lock and key at home. Honey extracted and stored at the outyards is always liable to be stolen.

One large power extractor, particularly one of the new radial type explained under Extractors, as already stated, will cost much less than half a dozen small hand machines. The big machine will do very much faster and cleaner work—that is to say, the combs will be much drier when returned to the hive. It has been estimated that, compared with a hand machine, a power extractor will save from ten to twenty per cent of the honey. While it may be argued that the honey in these very wet combs will go back to the bees, experience seems to show that under those conditions they are apt to gorge the honey and waste it, storing very little in the combs. The saving of the honey alone that would otherwise be gorged or wasted to a very large extent is a big item in favor of the central plant, to say nothing of the time saved.

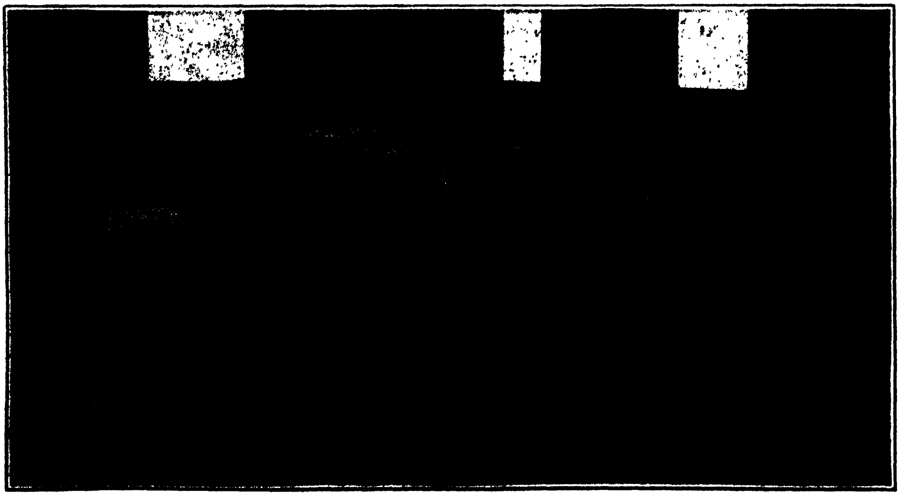


Rex Tabor's honey house in California.

One man with a power extractor and power uncapping outfit can take the honey out of the combs as fast or faster than the men with the truck can get them out of the hives, bring them to the plant, and take them back. It is therefore best to haul in the combs from a whole yard and then begin extracting. Or one man can do all the work, take out the combs, load, drive to the central plant, extract, and return the combs to the hives. It is right here that the wife, mother, or sister can be of great help.

If the central plant is located at home and there are few or no bees at the home, there will be no trouble from robbing, especially if the building is properly constructed with self-closing screen doors with suitable escapes to allow the bees to get out of the building.

For further particulars on the advantages of the central plant see Extracting.



Tank room for the Tabor building. The tanks are located on a lower level so that the honey can run from the extractor directly into any one of the tanks. In front of the tanks is a pit so that the honey can be drawn off into square cans. The general arrangement is ideal.

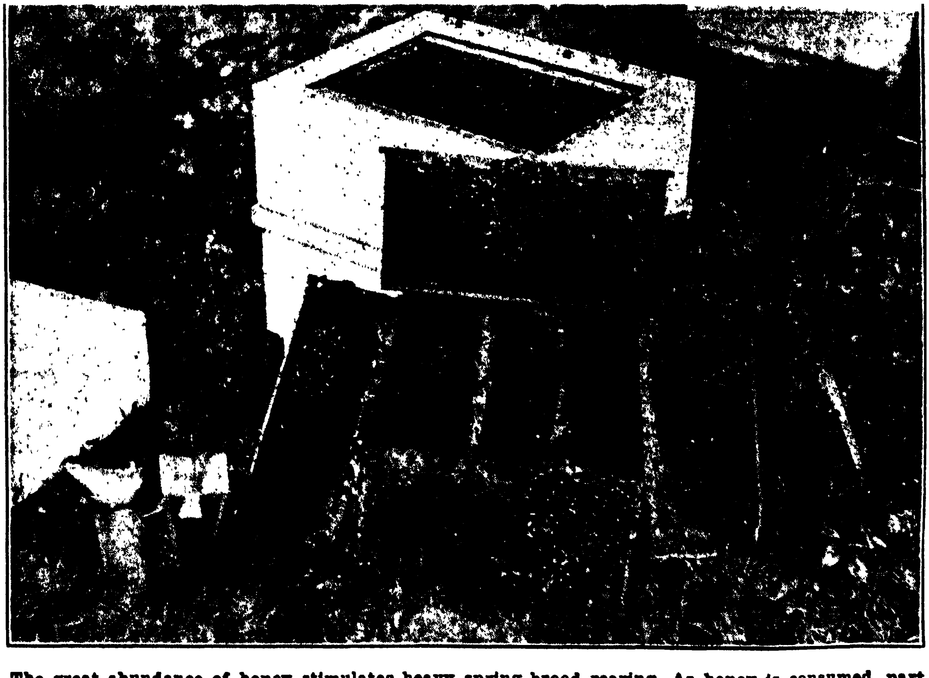
BUILDING UP COLONIES.—Under the heads of Increase, Spring Management, and Food-chamber will be found hints on building up colonies in the spring and fall; but this article will confine itself to the question of building up colonies so that they will be ready for the honey flow.

The number of worker bees in a normal colony varies during the different seasons of the year from a few thousand up to probably 60,000 to 80,000 or even more in some cases. The number is usually lowest in established colonies in early spring at about the time the first young bees begin to emerge in any considerable numbers. From this time on, if conditions are favorable for brood-rearing, the amount of brood is increased rapidly until the greatest capacity of the queen for egg-laying has been reached. This maximum egg-laying is maintained for a short time only, after which the amount of brood is greatly reduced, and later in the season, as the older bees die off, the number of workers in the colony decreases to that which is normal for winter. Thus in early spring a colony is strong as to numbers if it contains as many as two and a half to three pounds of bees (about 12,000 to 15,000 individuals), but it is not really strong two months later unless it contains 60,000 or more workers, the increase in numbers during the spring building-up period being usually more than five-fold in prosperous colonies. In tropical and subtropical countries the increase is not so great. (See Brood and Brood-rearing.)

It is fortunate for the beekeeper that the bees regulate their numbers in this way according to the needs of the season; for this makes it possible for them to store a surplus of honey during the honey flow and reduce the amount they consume at other times, provided the large population comes on at the right time for the honey flow. The most important thing in all beekeeping management is to have the largest number of workers come on the stage of action at the right time to take full advantage of the honey flow.

Harvest Hands of the Hive

After brood-rearing is begun in earnest in the spring it usually requires about two months for colonies of normal early spring strength to build up to full working strength, the gain during the first month usually being slow but becoming rapid during the second. In localities where the main honey flow usually begins about two months after the beginning of



The great abundance of honey stimulates heavy spring brood rearing. As honey is consumed, part of the food-chamber is filled with brood.

spring brood-rearing, this works out well for the beekeeper, since it furnishes a large force of young workers just when they are most needed. For example, in the northern portion of the United States where the honey flow usually begins in June most of the workers that gather the crop must be reared during April and May, and, in order that these workers shall be young and vigorous when the honey flow begins, most of them should be reared during May. Colonies which build up most rapidly just before the main honey flow usually store more surplus than those of equal numerical strength which build up more slowly, since more of their workers are young and, therefore, capable of a greater amount of work.

These workers are the "harvest hands" of the hive; and, if the flowers and weather do their part, the crop of honey will usually be much or little according to whether the workers to gather it are many or few. A great horde of workers coming on the stage of action at just the right time is the goal toward which the beekeeper has been working since last summer. So far as he is concerned, this great army of workers is that for which all the workers born at other times have existed. The bees reared previously have been useful only inasmuch as they have contributed to the final production of these "harvest hands," and bees reared later are useful only inasmuch as they are able to contribute to the maintenance of the colonies until next season, unless there is a later honey flow which they may help to gather.

The period of brood-rearing just preceding the honey flow, therefore, has a significance not found at any other season. Whether the main honey flow comes in March and April, as among the orange groves of California and in the tupelo and orange regions of Florida, in June and July, as in the clover region of the North, or during August, as in the buckwheat region of New York and Pennsylvania, the size of the crop of honey that can be harvested depends largely upon the amount of brood reared during the six or eight weeks just preceding the beginning of the main honey flow.

Since the tendency to rear brood is strongest in the spring, the beekeeper whose location furnishes the main honey flow immediately after the period of natural spring brood-rearing is fortunately located, for he then produces his workers for the honey flow at the time the bees are most willing to co-operate. If anything prevents the colony from reaching its peak in brood-rearing in the spring, such as weakness or insufficient food, it may climb to its maximum strength later in the season when normally the tendency to rear brood would be less intense; but, after the first spurt of extensive brood-rearing of the season, it is difficult to induce colonies again to rear as much brood during the same season.

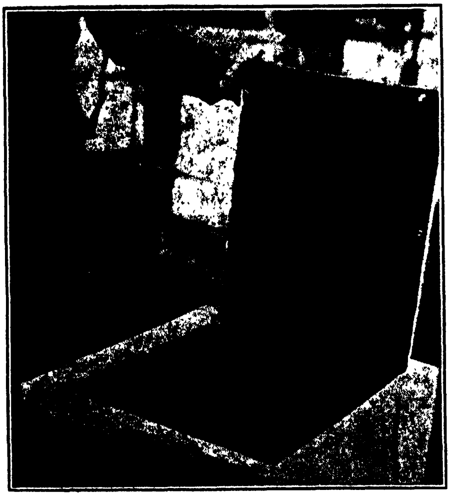
When there is a succession of honey flows during the season having an interval of dearth between, the bees usually increase brood-rearing in response to each honey flow. They can also be induced to rear a large amount of brood after the natural period of heavy brood-rearing in the spring by stimulative feeding (see Brood and Brood-rearing, Feeding and Feeders, and Food-chamber); but during the natural building-up period of spring they will rear brood extensively even in the absence of an early honey flow and without stimulative feeding, provided they have enough bees to take care of a large amount of brood, a good queen, plenty of honey and pollen stored within the hive, and water easily available. Brood-rearing at this time is apparently stimulated chiefly by the oncoming of spring, though even in the spring more brood is usually reared if some early nectar and pollen can be brought in from the fields.

Building Up for Early Honey Flow

Building up for an early honey flow, especially in the North, is therefore a relatively simple matter with colonies that have wintered well and have a good queen. Colonies that come through the winter with two or three pounds of bees that have not been unduly aged by winter and that have a vigorous queen need only to have abundant food (honey, pollen, and water), ample room for the queens to lay eggs, and protection from cold winds and low temperatures of early spring, to cause them to build up to powerful colonies within two months. Weaker colonies build up slowly, sometimes requiring three or four months to reach full summer strength.

To have most of the colonies strong in early spring involves not only good wintering (see Wintering), but also condi-

tions during the previous late summer and fall favorable to the rearing of sufficient young bees for winter. The first steps toward the building-up of colonies for an early honey flow should, therefore, be taken the preceding July or August by seeing that each colony has a vigorous queen and also sufficient stores (see Food-chamber) if there is no fall honey flow, as well as sufficient brood-rearing room to insure the rearing of young bees for winter. The second step is that of good wintering to conserve the energy of the bees which form the winter colony; and the third or final step is that of providing conditions favorable to heavy brood-rearing in the spring when the instinct to rear a large amount of brood is the strongest. Weak colonies in the spring are usually unprofitable and should be eliminated as far as possible by adding package bees.



An upper story full of honey supplies necessary stores for building up to great strength.

Remembering that the bees are more than willing to do their utmost in brood-rearing in the spring, especially in the North, the beekeeper needs only to see that they are not hindered in carrying out their own program in their own way. If egg-laying should be stopped entirely for a single day when the queen should be laying at full capacity, the number of workers that will be ready for the early honey flow is thereby reduced by the number of eggs the queen should have laid. In some cases the eggs laid by a queen in a single day at this time result in a half pound of young bees three weeks later. It is, therefore, extremely important that nothing shall be permitted to interfere with brood-rearing at this critical time.

During the first half of the building-up period it is better if the bees rear brood only moderately. The cool weather of early spring (April in the North, February or March farther south) is advantageous in tending to hold back extensive brood-rearing during the first month of the building-up period. Stimulative feeding and the spreading of brood to increase brood-rearing should not be practiced at this time. These, if done at all, should be done later, during the month just preceding the main honey flow. Usually the instinct to rear brood extensively is so strong in early spring that feeding to stimulate brood-rearing is unnecessary if the colony is well supplied with stores.

When stimulative feeding is practiced it should not be begun until three or four weeks previous to the beginning of the main honey flow and should be continued until the honey flow begins if sufficient nectar is not available. Stimulative feeding and spreading brood are of greater value in locations which do not furnish a surplus honey flow immediately after the spring building-up period, in which case these measures may be necessary to increase brood-rearing after the colonies have passed their period of heavy brood-rearing in the spring, especially if there is a dearth of nectar at the time the bees should be rearing the workers for the honey flow.

Spring Protection

Colonies that have been wintered outside should be left packed until a week or two before the honey flow, if this can be done without too much trouble. Colonies that were wintered in the cellar should be well protected from wind and the covers should be left sealed down during early spring unless it becomes necessary to open the hive. By looking in from below, they may be examined without removing the cover. In some locations beekeepers find that it pays to pack the bees after they are taken out of the cellar, though in most cases this is not done.

Influence of Good Combs

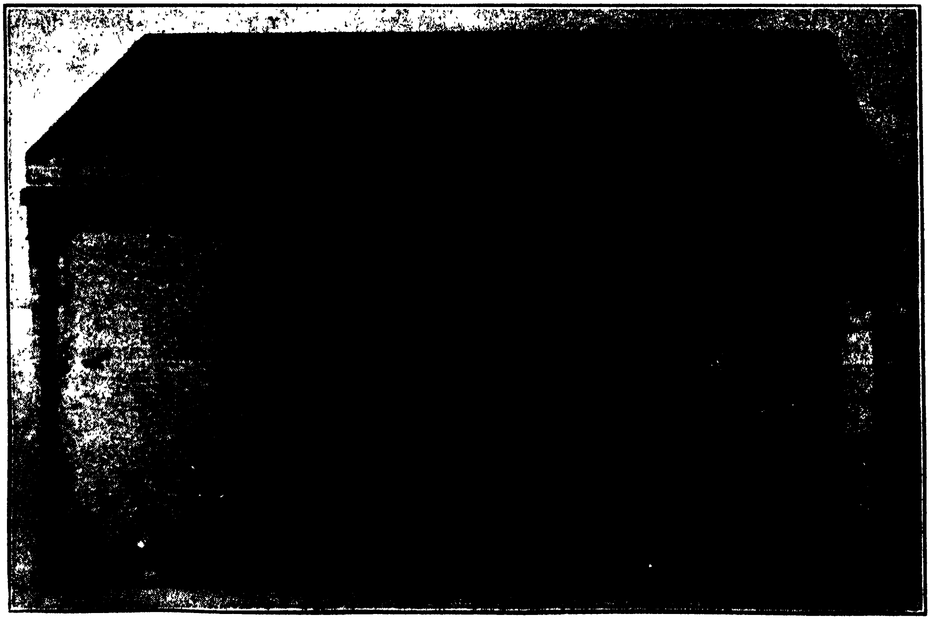
In order that the bees may rear the great army of workers for the honey flow there must be sufficient room in the combs for the greatest amount of brood that the

colony can produce. While this might all be crowded into nine or ten standard combs, it is usually spread over more. For this reason the combs should be as nearly perfect as possible, for imperfect combs in the brood-frames not only reduce their capacity for brood-rearing, but they also stand in the way of the rapid expansion of the brood-nest in the spring. (See Combs.) If a comb which is not suitable for brood-rearing is between the comb on which the queen is working and the other combs beyond, this imperfect comb stands as a barrier to progress in brood-rearing. Drone comb in the lower corners of the brood-frames and comb that is too badly stretched to be used for worker brood in its upper portion greatly reduce the capacity for worker brood, and when two stories of such combs are used to supply additional room for brood-rearing, this imperfect comb near the top-bar stands as a barrier to the free expansion of the brood-nest through the two stories.

Influence of Abundant Food

Most colonies that are normal in April, but which fail to develop their full strength before the honey flow in June, fail because of a lack of stores. One of the hardest things for beekeepers to learn is the surprisingly large amount of food needed for the colony to rear the large force of workers required to gather the crop of honey. During the latter half of the building-up period the amount of brood is increased with astonishing rapidity, provided the bees have sufficient food to convert into young bees. When there is no opportunity to gather nectar from the fields at this time on account of cold or wet weather the stores of honey within the hives disappear rapidly; but, if the reserve supply runs low, brood-rearing is reduced to a degree that is ruinous at the very time that the "harvest hands" are being reared. (See Brood and Brood-rearing.)

In the clover region there is an old saying among beekeepers something like this: "If the bees do well on the early flowers and fruit bloom, there will be a good crop of honey in June." This old saying implies some mystic relation between the two, by which it is possible to predict what the honey crop will be by noting how well the early flowers yield. This relation is no longer a mysterious one; for the up-to-date beekeeper, by supplying the deficiency in stores when the early flowers fail, is still able to produce a crop of honey, as he thus furnishes the food which is necessary to produce the workers that gather the crop.

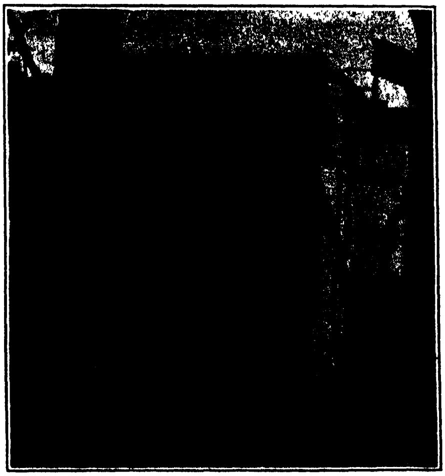


The food-chamber is simply a hive body well filled with honey.

An Automatic Feeder

During the month of May in many of the northern states, and during April or earlier farther south, most of the bees which are destined to make the "harvest hands" are being reared. Whether the food used in rearing them is being brought in from the fields or is being supplied by the beekeeper through feeders or is stored in the hive, the amount must be sufficient if the colony is to attain full strength in time. One of the easiest ways to insure this is to give each colony a second story of combs which are about two-thirds or more filled with honey. This second story becomes an automatic feeder, feeding the bees only as food is needed; and, in many localities at least, such a feeder, in addition to being automatic in its action after being filled the first time, is usually refilled each season without cost to the beekeeper, because of the better condition of colonies thus abundantly supplied with stores. (See Food-chamber.)

Such a large supply of honey apparently stimulates brood-rearing in the spring, and, as the honey is consumed, the queen usually enters the second story, expanding the brood-nest into it during the period of greatest brood-rearing when a single story may not furnish enough room for brood, pollen, and honey.



A double-walled hive with packed food-chamber protects the brood during cold nights.

This second story partly filled with honey, therefore, not only acts as an automatic feeder, but it also supplies room for additional brood-rearing at the time this is most needed. Some beekeepers use a shallow extracting-super for this purpose, which they call the food-chamber, while others use the full-depth extracting-

Lots of brood previous to the main honey flow enables such colonies to store good crops even during ordinary seasons.

supers. If shallow supers are used they should be completely filled with honey. One such super is supplied for each colony. This is tiered up among the other supers during the honey flow so that it is filled with good honey, and at the close of the season, when the regular supers are taken off, this food-chamber (now filled with sealed honey) is left on the hive.

If a second story is not used to supply the bees with ample stores for spring brood-rearing, the next best way is to save over combs of sealed honey and give these to the colonies as needed during the spring. Each colony should have the equivalent of at least two full combs of honey on hand as a reserve supply at all times throughout the building-up period. If combs of honey have not been saved for this purpose it is necessary to feed the bees during the building-up period, unless the colonies were unusually well supplied with stores the previous fall or early nectar is abundant. The syrup may be given in small amounts daily as in

stimulative feeding, or ten to fifteen pounds may be given at one time if more convenient.

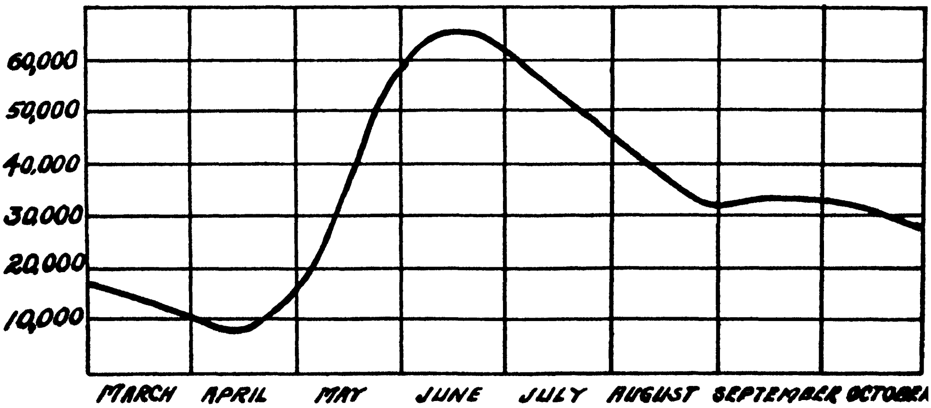
It is important that bees in early spring should have reserve stores of pollen. These are almost as important as combs of sealed stores. In some localities, when there is no natural pollen in the hive the bees will rush out in the early spring, go to some barn searching for feeding troughs in stables, and help themselves to the ground feed; for brood can not be reared without something besides mere honey or syrup. (See Pollen; read as to the Necessity of Pollen for Brood-rearing.) Of course, after bees can get natural pollen from the fields during warm weather they usually find an abundance for all their needs.

Peak of Population at Right Time

Sometimes the main honey flow does not follow immediately the period of heavy brood-rearing of spring, and these "harvest hands" may become consumers instead of producers; but these strong colonies can usually gather enough to live on, being better able to gain a living from minor sources of nectar than weaker colonies, except during a complete dearth of nectar. But after the colonies have built up to great strength it is difficult to maintain their strength until a later honey flow on account of the reductions in the amount of brood.

In some locations, such as the sweet clover region, some of the southern states, and a strictly buckwheat region, the main honey flow may come as much as two months after the bees have passed the peak of spring brood-rearing, assuming that the colonies were normal in strength and had sufficient food to have reached their maximum in brood-rearing early in the spring. In such cases some beekeepers resort to such measures as stimulative feeding or spreading the brood, to induce more brood-rearing just previous to the main honey flow. Others move their bees to another location to gather a crop of honey from some earlier source while the colonies are strong, and then move them back again for the later honey flow. (See Migratory Beekeeping.) Some southern beekeepers sell package bees to utilize the excess of workers which would be too old to be of use when the honey flow comes on later; while still others divide the colonies before they reach their maximum in spring brood-rearing, making the division at a time which will permit both colonies to build up to the greatest strength in time for the belated honey flow. The last-named plan has been used quite successfully in the buckwheat region, and especially in the great sweet clover region west of the Mississippi. (See Dividing.)

When the main honey flow comes at the same time that the bees are rearing the great horde of "harvest hands" in the spring, as too often happens in the case of weaker colonies and an early honey flow, of course, a full crop of honey can not be secured, for the field force is then small and the amount of brood to feed is large. The only hope in such cases is that the honey flow will last long enough to permit the bees to gather some sur-



The curved line shows the typical variation in colony population through the breeding season Figures at left indicate approximate number of bees. The month of greatest population varies for different localities.

plus before it closes, but the remedy is better wintering or adding a pound of package bees early in the spring to strengthen them.

When there is a possibility of a honey flow still earlier, at the beginning of the heavy brood-rearing period of spring, as sometimes happens in the North when the maples yield profusely, or in the citrus region when the bloom comes unusually early and the bees are late in building up, brood-rearing is greatly stimulated and but little honey is stored because of a lack of "harvest hands."

Equalizing Brood

During the latter half of the building-up period, some beekeepers make a practice of equalizing the brood among the colonies in order to build them up alike in strength. This should not be attempted until the strongest colonies have at least six or seven frames of brood. At this time a frame of brood, most of which is nearly ready to emerge, may be taken from each of the strongest colonies and, together with the adhering bees, given to the colonies which are less strong, but not to the weakest ones. Care must be taken to be sure that the queen is not taken away with these frames of brood. The comb of brood in each case should be given adjacent to the other combs of brood in the weaker colony to keep the brood-nest as compact as possible, thus preventing any brood from being chilled during cool nights. The bees on the empty comb taken from the weaker colony to make room for the frame of brood are shaken back into their hive, and the empty comb is given to the colony from which the brood was taken, placing it between the outer comb of brood and the comb which contains honey and pollen at the side of the brood-nest.

The weakest colonies are left until after all of the medium colonies have been brought up to the same number of combs as the strongest ones, after which these may be built up quickly by giving them several frames of emerging brood from the stronger colonies. When several combs of emerging brood with adhering bees are given at one time the combs from different colonies should be alternated to mix the bees so there will be no fighting. When equalizing the brood in this way, it frequently happens that the stores may also be equalized.

If at the beginning of the honey flow more combs of brood are needed than can be drawn from the stronger colonies, they may be drawn from weak colonies, thus reducing these to one or two frame nuclei which are then left to build up to full colonies for winter.

If either of the brood diseases is present in the apiary, it is not safe to exchange the combs in this way.

It is sometimes advisable to shake bees from extra strong colonies to unite with weak colonies.

It is sometimes advisable to unite two or more weak or medium colonies to make one stronger colony, but it is usually best not to do this early in the spring. It should be done at the beginning of the honey flow. A better way is to add a pound or two of package bees early in the spring. (See Package Bees. See Uniting. Also read carefully the articles on Spring Management, Spring Dwindling, and Feeding.)

BULK COMB HONEY.—See Comb Honey.

BUMBLEBEES.—The bumblebee family, or *Bombidae*, includes only two genera, *Bombus*, or the nest-building bumblebees, and *Psithyrus*, or the social parasitic bumblebees. About 300 species and many varieties of *Bombus* have been described in

the world, and of *Psithyrus* almost 30 species. In America there are 80 species of true bumblebees and 8 true social parasites. Bumblebees are found throughout North and South America, extending northward to Discovery Harbor, in latitude 81 degrees, and to an altitude of 13,600 feet at Cuzco, Peru. The arctic bumblebees, which are on the wing less than three months, are very industrious and gather pollen and nectar from flowers for the larger part of the 24 hours of the day. Bumblebees are also widely distributed in Europe, Asia, and North Africa, but the great Saharan desert offers an effectual barrier to their southward extension. Australia and New Zealand have no native species, but three species were successfully introduced into New Zealand from England in 1885.

Bumblebees and Flower Pollination

As agents in the pollination of flowers bumblebees are second in importance only to honeybees. Many flowers are adapted wholly to their visits and are called bumblebee-flowers, as the larkspurs, aconites, columbines, red clover, jewelweed, turtlehead, Linaria, snapdragon, the closed and fringed gentians, besides a number of orchids. While they generally avoid very small flowers with a scanty supply of nectar, they resort to a great variety of blossoms, many of which yield valuable fruits. Although seldom seen on the inflorescence of the pear, they seek the apple bloom in large numbers. They are likewise very helpful in pollinating many blueberries, cranberries, gooseberries, and currants. While leaf-cutting bees (*Megachile*) are the chief pollinators of alfalfa, many flowers are tripped by bumblebees. The flowers of the squash, cucumber, and pumpkin are also very attractive to them. As in these plants the stamens and pistils are in separate blossoms, their productiveness is largely dependent upon bees.

Life History and Habits

In midsummer or early autumn, depending upon the species, a bumblebee colony produces males and queens. The males, which are about the size of the workers, are pleasantly scented and make long flights over the meadows and the open lands in search of the less active females. Before leaving the nest, to which they seldom return, the virgin queens fill the honey-sac with honey; and very soon after impregnation they conceal themselves in moss or leaves, or burrow in the ground, where they remain till the following season. The period of hibernation is about nine months, species which begin sleeping in July awakening in March, while later species do not fly until May or June. The habits of bumblebees in England have been observed carefully by Sladen, and the following general account of their habits is based mainly upon his studies.

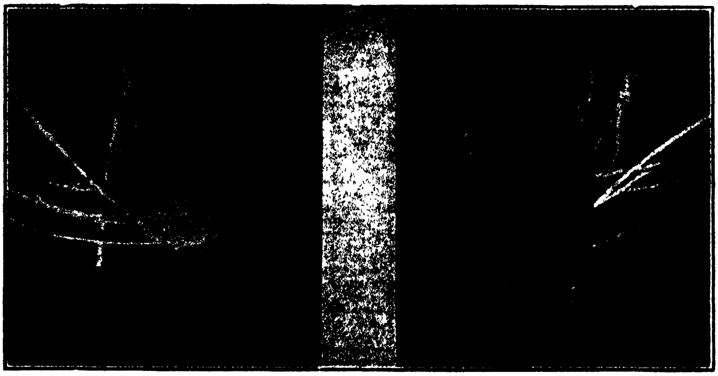


Fig. 1.—Two views of honey-pot of Bombus lapidarius. (After Sladen.)

Soon after the warmer weather of spring permits the queen to leave permanently her place of hibernation she begins to search for the nest of a mouse or mole in which to rear her colony. A mouse nest consists usually of a mass of soft dried grass with a hollow in the center. Many species of bumblebees prefer nests which are underground, while others select those which are on the surface. Access to the subterranean nests is gained through a tunnel usually not

far from two feet in length and about an inch in diameter. Queens may often be seen examining the ground in fields in search of the openings to these tunnels. Before she departs for the field, the queen forms a memory picture of the location by describing above it a series of gradually widening circles. In the center of the nest a small cavity is formed about an inch in diameter and a little less in height, with an entrance about the size of the queen's body.

On the center of the floor of this cavity she stores a small mass of pollen gathered from flowers and moistened with honey. In a round cell of wax about the size of a pea, built on top of the pollen, from six to twelve eggs are laid, and the top of the cell is then sealed over. According to Sladen the wax is much softer than that of the honeybee, and exudes from between the segments on the upper side of the abdomen instead of being excreted in little pockets on the ventral side of the abdomen as in the honeybee. A honey-pot is built in the entrance to the cavity and filled with honey, which the queen uses in the nighttime and in rainy weather. It is about the size and shape of a small marble, with open mouth; and, although very thin and fragile, it remains intact for a month, which is as long as it is needed. (Fig. 1). The supply of honey is frequently consumed and renewed, and is, consequently, much thinner than that of the honeybee. In large colonies additional honey-pots are built near the edge of the comb, and many of the cocoons are filled with honey, the number of which may amount to three or four hundred.

Fig. 2.—Nest of Bombus terrestris showing cluster of cocoons with groove in the center in which the queen sits, and honey-pot. (After Sladen.)

Except when she leaves the nest to procure food the queen incubates the cell constantly to keep the eggs warm. They hatch in four days. The larvae feed on the mass of pollen and also on a milky food of partially digested pollen and honey prepared by the queen. This liquid is injected into the wax cell through a minute hole in the top. At first the larvae are provided with a common supply, but later each is fed separately. When the larvae are five days old they begin to grow very rapidly and the cells expand into a large globular bunch or bag, in which the position of each can easily be discerned. On the eleventh day they reach their full size, and each larva spins about itself a thin papery but very tough cocoon. The cocoons stand upright and form a compact cluster with a smooth concave groove in the center, in which the queen sits to furnish the warmth needed to mature the first brood of workers (Fig. 2.) On the twenty-second or twenty-third day perfect workers emerge from the cocoons by cutting a hole in the top either alone or with the aid of the queen. The newly hatched bees are a dull gray and move about very feebly, but by the third day they have acquired their natural colors and strength and are ready to depart for the field. The life of a worker bumblebee in midsummer is about four weeks.

As soon as the larvae of the first brood spin their cocoons the queen begins to build a row of cells along the outer edge of one side of this cluster parallel with the central groove, and later a second row on the other side of the cluster. She then

Fig. 3.—Nest of Bombus agrorum, showing symmetrical arrangement of comb. (After Sladen.)

lays a variable number of eggs, but usually from six to twelve in each cell. As soon as the workers become sufficiently numerous to provide supplies for the colony the queen no longer leaves the nest and may lay a new lot of eggs daily. The history of the eggs in the later cells is similar to that of those in the first cell, except that the larvae are fed largely or wholly by the workers, and the cluster of cocoons is convex without a central groove. The structure of cocoon clusters varies with different species. Those of the English *Bombus terrestris* are loose and irregu-

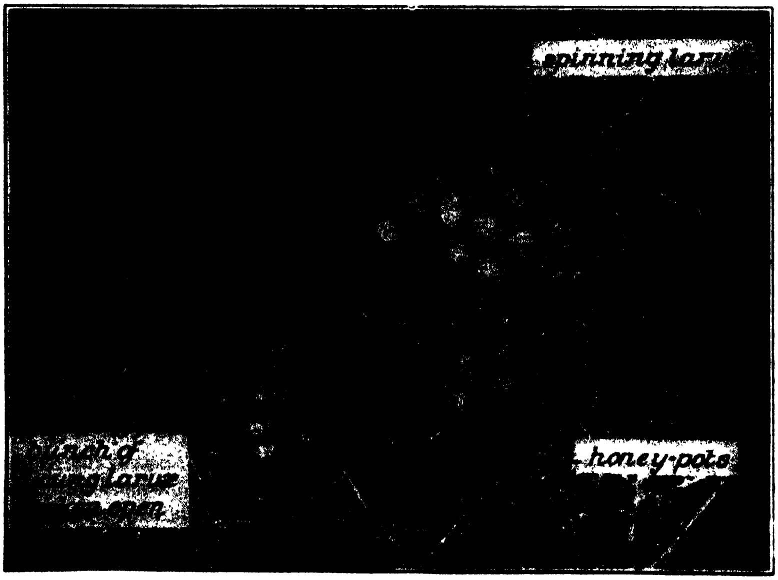


Fig. 4.—Nest of Bombus lapidarius. (After Sladen.)

Fig. 5.—Bombus americanorum; a, queen; b, worker. (After Sladen.)

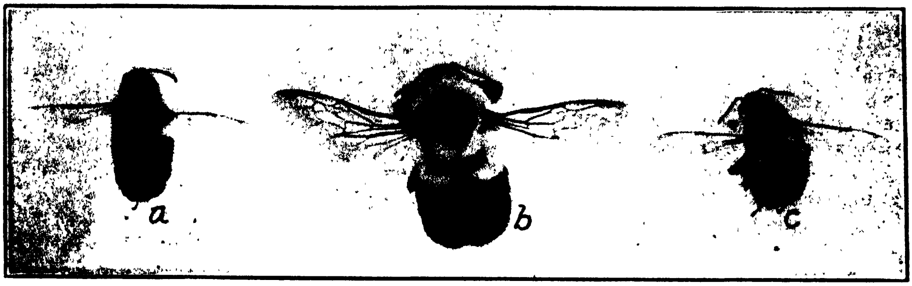


Fig. 6.—Bombus fervidus; a. male; b, queen; c, worker. (After Sladen.)

Fig. 7.—Bombus impatiens; a, male, b, queen; c, worker. (After Sladen.)

Fig. 8.—Psithyrus laboriosus; a, queen; b, male. (After Sladen.)

lar, while those of *B. agrorum* are compact and globular and are arranged symmetrically in a ring around the nest (Fig. 3). Underground species may protect the top of the comb by a roof of wax; but this in surface dwellers is reduced to a mere disc or is entirely wanting. On very hot days the nest is ventilated by one or more workers standing on the comb or in the entrance and rapidly fanning with their wings. Night brings no rest to the colony. Its activity even increases for now all the bees are at home and busily engaged in caring for the brood.

Pollen is never put in cells containing honey, but is stored in empty cocoons or in tall columnar cells, which may be over an inch high and half an inch in diameter, near the center of the nest. A few species store it in little pockets on the side of the wax-covered bunches of larvae, called by Sladen pocket-makers to distinguish them from the pollen-storers. The workers gather the pollen and load it in the pollen-baskets in the same manner as described for the honeybee.

The culminating event in the history of a bumblebee colony is the production of males and queens, for it is upon this act that the life of the species depends. This is not undertaken until the old queen has laid from 200 to 400 worker eggs, according to the species, and the colony is in a high state of prosperity. Both sexes may occur in the same cluster of cocoons, or it may consist wholly of males or females. In exceptional cases a colony produces exclusively males or queens. The males appear earlier and are about twice as numerous as the females. One hundred to five hundred males and queens may be raised, according to the strength of the colony. The males live for about three weeks, and, like the queens, after once leaving the nest seldom return.

With the departure of the males and virgin queens from the nest, the purpose of the colony has been attained in providing for the continuance of the species another year, and the closing days of its existence are now fast approaching. The old queen begins to fail, her body becomes denuded of hair, and her productiveness decreases. There are not sufficient eggs to keep the colony busy, and laying workers appear, which, however, produce only males. Finally brood-rearing ceases, and the comb begins to mold. There is no longer an abundance of flowers, and the surplus of honey is consumed; then the older workers die one by one and the dozen or more remaining become idle. "One night, a little cooler than usual," says Sladen, "finding her food supply exhausted, the queen grows torpid, as she has done many a time before in the early part of her career, but on this occasion, her life work finished, there is no awakening."

More recently the habits of American bumblebees have been investigated by T. H. Frison, whose observations differ in a number of particulars from those of Sladen. According to Frison, *Bombus auricomus* lays each egg in a separate cell, a characteristic not known in any other species of bumblebee. According to the same author *(in litt.)*, the number of eggs laid in a cell varies, depending upon the species, some laying at times as many as twenty eggs in a single cell. The cells are built about 12 hours before the eggs are laid and are constructed of a mixture composed of wax and pollen. The largest number of eggs laid by the queen of *B. auricomus* in a single day was five, but species producing large colonies (such as *B. americanorum)* were found to lay many more than this. While brooding over the comb a queen of *auricomus* frequently makes a loud purring noise accompanied by a quick movement of the wings. This has not been observed in other species. The virgins of all species usually, if not always, mate outside of the nest, and those of some species, like the American bumblebee *(B. americanorum)*, often on the ground among the vegetation within a few yards of the nest. The mating of other species commonly takes place while they are resting on the leaves of trees.

Egg-laying workers occur in the nests of bumblebees, as in the hives of the honeybee, but they are seldom numerous. Six was the largest number observed by Frison at one time in a single colony. Within 13 days these workers laid nearly 50 eggs. Worker eggs do not differ in appearance from those of the queen except in being smaller; but they produce only drones, which are apparently similar to the males reared from queen eggs. No difference can be detected between the cells in which the male and female eggs are laid.

The first workers produced are comparatively small, but they become larger and larger as the season progresses. Unlike the queens and workers of the honey-

bee, these two castes in the bumblebees do not differ in structure. The only discernible difference is in size. The workers are nearly duplicates of the queen, says Frison, and possess nearly all her instincts. The small size of the workers early in the season is almost certainly due to nutritional retrictions, while an abundance of proper food causes the production of the larger bees. The larvae are fed on pollen and a liquid food, or foods whose composition has not been determined. This is injected into the cell from time to time by the workers through a small hole in the top.

Frison succeeded in inducing queen bumblebees to build their nests in artificial domiciles, the covers of which could be removed whenever desired, and the nest examined. After several preliminary experiments a nearly square cypress box was used with a lid which opened by hinges, beneath which was a second removable glass top. The bottom of the box was open, and screened with very fine copper gauze, which permitted the escape of moisture. A spout of tin or of garden hose was attached to the lower side of the box, through which the bees passed in and out. Suitable material for a nest, as fine grass, was placed inside the box, which was buried in the ground, so that the end of the spout was level with its surface. Seventeen out of a total of 36 domiciles were selected by queen bumblebees for nesting quarters. The boxes should be placed in the ground soon after or before the queens emerge in spring from their winter quarters.

More important even than the attracting of queens by artificial domiciles is the fact that Frison succeeded in inducing the queens of certain species to start and rear normal colonies in confinement unaided by introduced workers. Furthermore, it was demonstrated that the mating of certain species could be controlled.

The nests of bumblebees in the field under normal conditions may also be examined, according to E. R. Root, by the intelligent use of smoke. The nest should be approached cautiously and a gentle column of smoke blown into the entrance. The bees will presently be driven from the nest and will make no effort to protect it. So long as the air is filled with smoke they will not offer to sting. Root has taken apart a bumblebee's nest, while the bees hovered over it in the smoky air, making no effort in self-defense, but quickly returning to the nest when it was replaced in its original position. By keeping the air filled with smoke he has also removed wasps' nests from the eaves of buildings or from the branches of shrubs, with many of the wasps flying harmlessly about his head. Frison finds that, while some species are very vicious, others are so docile that they can be handled almost with impunity. He has successfully employed anesthetics in opening their nests.

A large and common bumblebee east of the Rocky Mountains is *Bombus americanorum*, which has a tongue 14 mm. long. According to Franklin, the nests are usually built on the surface of the ground and are composed of dried grass. A large nest of this species contained one queen, 153 workers, and 23 males. There were also in the nest 78 cells of larva, of which 18 were queen-cells. Another common species is *B. fervidus*, which is found in nearly every state in the Union and in Canada. According to Plath, the nests are built both upon the surface and underground. In three nests there were from 100 to 125 workers each. Later in the season each colony produced more workers and more than 100 males and young queens. The queens are on the wing the last of May. *B. impatiens* occurs throughout the eastern United States. (Fig. 7.) Of 16 nests examined by Plath all were subterranean. They were from one to three feet below the surface, and had tunnels varying from 18 inches to five feet in length. A nest taken by Franklin contained 340 bees, of which four were queens and 15 males. There were 330 unbroken cells, most of which were queen-cells. Another very common eastern species of bumblebees is *B. vagans*. Of six nests taken by Plath near Boston, Mass., two were surface and four subterranean. The largest nest contained the old queen, over 70 workers, and a large number of brood-cells. Most nests appear to be started late in May, and the colonies break up in September.

The Social Parasitic Bumblebees

Many bumblebee colonies are infested by parasitic or false bumblebees belonging to the genus *Psithyrus*. They are also called inquiline or guest bumblebees. Eight species are known in America north of Mexico and Central America. It is a singular fact that not a single species is cer-

tainly known in South America. A common species widely distributed in the United States is *P. laboriosus* (Fig. 8.) A true worker caste is entirely absent and only males and females are produced. They do not build combs nor gather pollen and nectar for their young, but live in the nests of the true bumblebees, at whose expense their brood is reared.

They were long supposed to be commensals, living with the bumblebees and doing little harm or possibly being of some benefit; but much information in regard to the habits of two English species has been gained through the observations of Sladen. Like the bumblebees, they hibernate during the winter, but begin to fly a little later in the spring. A *Psithyrus* queen seeks to enter the nest of the host bumblebee soon after the first brood of workers has appeared. Little opposition is then offered by the doomed colony, which soon becomes accustomed to her presence. So long as the workers are too few to provide ample food supplies, the intruder with instinctive cunning waits until they have become numerous enough to care for herself and her brood. As soon as the nest has become populous a crisis is precipitated by the *Psithyrus* queen's preparing to lay eggs. Aroused by this invasion of her rights, the bumblebee queen apparently attacks the usurper, although she is doomed beforehand to defeat. Protected by a thick, tough integument and armed with a larger and more curve sting, the parasitic queen usually kills the bumblebee queen. The *Psithyrus* queen is at first compelled to protect her eggs from the *Bombus* workers, but they soon care for her brood as faithfully as for their own. In Austria two species of *Psithyrus* are reported to live amicably with their hosts, producing males and females.

If the *Psithyrus* queen waits too long and then enters a colony of the host bumblebee which has a strong company of workers, she is at once furiously assailed by overpowering numbers; and, although fighting valiantly, she is finally slain. Before she is destroyed, however, a dozen or more of her assailants are sometimes killed. If two *Psithyrus* queens enter the same nest they seem never to fight with each other, but one soon goes away. The parasitic bumblebees visit a variety of flowers, but they show a preference for composites like the thoroughwort and goldenrod, which are rich in nectar. Their visits are made in a leisurely way very unlike those of the bumblebees.

The two genera, *Bombus* and *Psithyrus* have doubtless been derived from a common stock. *Psithyrus* shows evidence of degeneration in the loss of the pollen-baskets, the smaller eyes, and the untoothed mandibles. In explanation of the origin of the parasitic habit Sladen points out that the queens of several common species of *Bombus* often enter the nests of other species of this genus, fight a duel to the death with the queen, and if successful (which is unusual), lay their eggs and assume the duties of the foundress of the colony. *B. terrestris* behaves in this way in the nest of the nearly-related European species *B. lucorum*, but with the difference that she usually succeeds by means of her greater alertness and ferocity in killing the *lucorum* queen; and, *B. lucorum* being an early species, she frequently does not enter the *lucorum* nest until the first workers are beginning to emerge. If this practice were to become habitual, an inquiline bee similar to *Psithyrus* would be likely to result.

Previous to 1915 not a single inquiline bee had been reported in a bumblebee's nest in this country. Since then, accordin to Frison, four species of *Psithyrus* have been recorded in the nests of five species of American bumblebees. The *Psithyrus* queen is not always victorious in a battle with the bumblebee queen, for Frison found one dead in the nest of *B. americanorum*, evidently having been stung to death by the rightful queen.

BURR-COMBS.—See Thick-top Frames under the head of Frames.

C

CAGES FOR QUEENS.—See Introducing.

CAMPANILLA.—It is an important honey plant of western Cuba. The honey is white and equal to alfalfa or sweet clover. See "Honey Plants of North America."

CAMPECHE.—See Logwood in "Honey Plants of North America."

CANADA THISTLE.—Outlawed everywhere, it is a source of very fine light honey. At one time it was an important source of honey. See "Honey Plants of North America."

CANDIED HONEY.—See Granulated Honey.

CANDLES OF BEESWAX.—See Wax Candles.

CANDY FOR BEES.—There is just one kind of candy that is used universally by beekeepers for queen-cages. While excellent for this purpose it should not be used as winter food unless in pans, where, if it becomes soft, it will not run down and kill the bees.

This is what is popularly called the "Good" candy, after I. R. Good, of Nappanee, Indiana, who introduced it into this country. It was, however, first made many years before by a German named Schloz. (See "Langstroth on the Honeybee," page 274, 1875 edition.) By Europeans it is, therefore, called the Schloz candy.

How to Make

It is made of a first-quality of extracted honey or invert sugar and powdered sugar. If honey is used it should be of the best quality of table extracted honey from an apiary where there is no foulbrood and, if possible, from a locality where there has never been any disease. The powdered sugar must be cane or beet with no starch. There are two kinds of frosting sugar—one with starch and the other without. The latter should be used. While starch is not necessarily fatal to queen-cage candy, experience shows that queens can be sent only short distances on a food containing it.

Having secured the right ingredients, the honey (or invert sugar syrup) if granulated, should be heated to a temperature of 140 degrees to liquefy, and allowed to cool to about 100 degrees. The pulverized sugar should then be stirred in, a little at a time, with a big strong spoon or stick, adding all that it is possible for the honey to absorb. When the stick or spoon can not stir in any more, some powdered sugar should be spread on a molding board, and the mixture removed from the pan to the board. The dough should then be kneaded the same as ordinary bread dough, adding sugar from time to time to prevent sticking. The candy should be worked and worked by some good strong arms and hands until all the sugar has been incorporated that it is possible to get in, and yet not have it too stiff nor too soft and moist. The proportion should be about two pounds of invert sugar or honey to five pounds of powdered sugar. The kneading should be kept up for at least half an hour. If too much sugar is worked in, the candy will become dry and hard; if not enough, it will be soft, sticky, and shiny. If the candy has been handled properly it should hold its shape or form and not become sticky or "run" out of the candy hole in a queen-cage at a temperature of 80 degrees. Summer temperature will seldom exceed this; and if the candy holds its shape at this temperature it will do so when it is colder. It may then be set away in a closed tin pan and used as a food to fill cages.

During very moist hot weather it may be necessary, just before filling the cages, to knead in a little more sugar.

During exceptionally hot summers it

requires two pounds of invert sugar or honey to six of powdered sugar.

The holes for holding the candy in queen-cages should be lined with paraffin or beeswax, and the top covered with paraffined paper. The object of this is to prevent the moisture of the candy from evaporating and being absorbed into the wood. This absorption and evaporation would make the bee-feed dry and hard. It should be maintained not sticky but slightly moist and soft, to the journey's end.

Postal regulations in the United States require on the part of every queen-breeder who sends queens by mail one of two things—a certificate of inspection from a duly authorized bee inspector certifying that no bee disease has been discovered in the yard in which the queens are reared, a copy of this to go on every package; or in the event that there is no bee-inspection law, and, of course, no inspector, the postal authorities require a statement, duly attested before a notary, that the honey of which the candy has been made has been boiled 20 minutes in a closed vessel.

But experience shows that boiled honey does not make good queen-cage candy. The character of the honey is so changed by boiling that queens are apt to die on it in a short time. The real intent of the regulation, which is to prevent the dessemination of bee-disease, can be better subserved by using invert sugar in place of honey. (See Invert Sugar.) This is a syrup having about equal proportions of levulose and dextrose; and in this one respect it is very similar to honey; but, of course, it lacks some of the food elements of nature's product. However, because it has never been in contact with the bees, and therefore could contain no germs of disease, and because chemically it is so nearly like honey, it can be used in place of honey in making candy. As there is so much foulbrood present over the country, it is always safer to give to bees a candy that contains no honey.

Invert sugar syrup can usually be obtained of any large candy-maker. A very good article is sold under the name of Nullomoline by the Nullomoline Co., New York. This is made without acids, from granulated sugar, and is preferable to the ordinary invert sugar syrup made with the use of acids.

Ordinary invert sugar syrup runs from 10½ to 11 pounds per gallon. In order to make a good queen-cage candy it is necessary to boil this invert sugar until it has about the same consistency as good thick honey, namely, a syrup running about 12 pounds or over to the gallon. Unless the excess of water is driven off, the candy is liable to get too moist, making trouble afterwards. By boiling out the excess of water one can make almost as good a candy with the invert sugar syrup as he can with honey, although for long distance work, as will be shown next, a honey candy is better than candy made of invert sugar syrup.

For long-distance shipments, and for valuable queens, where proper precautions are taken in securing a honey that is free from disease, it is advisable to use a light-colored extracted honey of best quality in making queen-cage candy. This honey should come from a locality where there has never been any foulbrood, in order to be really safe. A queen-cage candy made with honey will hold its shape and consistency, or, more exactly, a soft mealy condition, slightly longer than a candy made of invert sugar. It probably contains some food elements also that are essential to long shipments. For many years the only queen-cage candy known was made from honey; but as the latter might convey bee disease to a new locality, an invert sugar candy is recommended for general shipments, using honey only for long distances and for valuable queens.

Hard Candy for Winter and Spring Feeding; How to Make It

Into a dish of hot water on the stove is slowly poured granulated sugar, which should be stirred constantly. The syrup should be very thick and the sugar all dissolved before boiling commences. If this precaution is not observed, some of the undissolved sugar is likely to burn, injuring the flavor of the candy and almost surely causing trouble with the bees later. If one has a candy thermometer, he should watch the temperature, and not let it go above 275 to 280 degrees F. Tests should frequently be made by dropping a very little of the syrup into cold water (about 50 to 55 degrees F.). When the boiling has continued long enough the drop of candy, having been cooled in the water, should be hard and brittle when taken out; but when placed in the mouth it should soften slightly, and become

tough. When this time has arrived, the syrup should immediately be poured on to paraffined or waxed paper on a table. The table should be perfectly level, and around the outside of the paper should be placed wooden sticks ¼ inch high to confine the syrup and prevent it from running off. When the candy is nearly hard, it may be creased or cut with a heavy knife so that it can be broken up into right-sized squares when hard.

The color of the candy when cold should be about that of light basswood honey. If it is darkened very much, it is scorched and unfit for the bees. To prevent the scorching, the fire toward the last should be reduced so that the syrup will boil slowly.

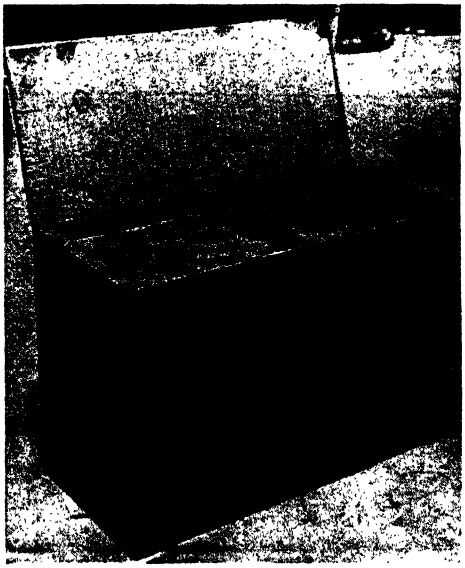
When the candy is first made, it is hard and glassy, and perfectly transparent; but after it stands for a little time it becomes somewhat sticky and crystalline; but this is all the better so far as the bees are concerned, for they are enabled to take it more easily.

The thin cakes of candy (being only ¼ inch thick) may be placed over the frames and under the regular cover, and in this way a colony may be saved that would otherwise be lost. The feeding of syrup, especially in the spring, is apt to cause great excitement and possibly robbing, and for this reason the candy is safer as it is taken slowly.

Caution.—Whoever makes the candy should clearly understand that if the mixture is scorched, even the slightest, it will make unfit food for spring or winter feeding. When the syrup is cooked nearly enough, there is great danger of burning, and it is *then* that the greatest care should be exercised.

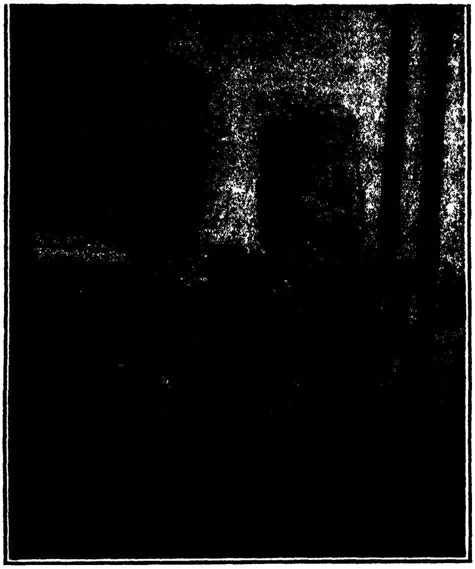
CANE SUGAR.—This is the common name applied to the sugar sucrose. Sucrose is made from the sugar cane and also from the sugar beet. When derived from the beet it should go under the name of beet sugar. Sucrose is found in pure honey in amounts up to 8 per cent. Only in a very few cases has pure honey been found which showed the higher figures. The standards for pure honey allow 8 per cent to be present. New honey generally contains more sucrose than old honey. There are present in honey before heating some enzymes (unorganized ferments) which have the power to invert the sucrose. Hence on aging, if heat has not been applied to kill this action, the per cent of sucrose decreases. Sucrose on hydrolysis or inversion form equal parts of dextrose and levulose, these latter being the predominent sugars of honey. (See Sugar; Invert Sugar.)

CANS.—Years ago honey in bulk form was shipped mainly in barrels and kegs; but, as explained under the head of Barrels, such wooden receptacles are inclined to leak and cause trouble between shipper and consignee. Moreover, when second-hand wood containers were used, a taint or unpleasant flavor would be given to the honey. For this reason tin cans, usually the five-gallon square can, two in a box, are now generally used for all bulk shipments of extracted honey in car lots or less than car lots. While the metal



Standard two-can shipping-case with strong partition in middle between the cans. Each 5-gallon can holds 60 pounds of honey.

containers costly slightly more per pound, there is comparatively little leakage and no impairment of flavor of the honey itself, provided, of course, that new cans are used. The regular five-gallon can, weighing 62½ pounds, can and all, is rather heavy to lift, yet two of them in a box can be very easily handled by a truck. On arrival the cans of honey can be placed in a hot room or in hot water



A truck-load of round wooden-jacketed cans just as they were received after shipment.

A honey can after being shipped loose in a box. Most of the honey had leaked out.

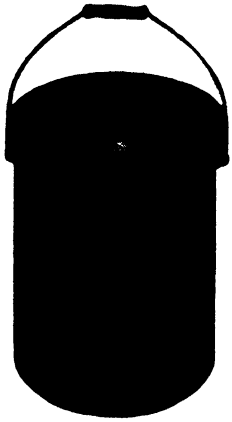
to liquefy the contents, if granulated. On the other hand, a keg of granulated honey presents a different proposition entirely. The head must be removed, when the honey is dug out with a spade or a hoe and then placed in a large metal boiler to be liquefied. (See Granulated Honey.)

Experience has shown that the old style round metal cans holding five gallons, even though jacketed with a veneer of wood, are very unsatisfactory for honey shipments. The illustration tells its own story. In the same way, square cans in a box that is too large are liable to arrive at destination in bad condition. See the illustration bottom of first column.

The fact that the five-gallon square can is used so universally for syrup and liquids of all kinds makes this form of container relatively cheap. For shipping gasoline and kerosene long distances or to foreign countries the five-gallon square can, two to a case, is almost universally used. The fact that these cans can be obtained on short notice from canning factories located all over the United States makes them almost instantly available and at competitive prices.

Large Metal Pails for Shipping Honey

In 1932 there was introduced to the beekeeping public a new type of container holding 60 pounds of honey, of the round pail type. It has been in successful



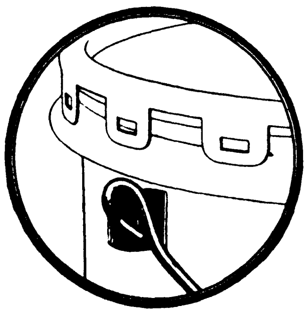
New type of container holding 60 pounds of honey.

use for several years prior to 1932 for holding and shipping paint and heavy oils. It is made of No. 24 heavy gauge metal, painted on the outside and lacquered on the inside to prevent corrosion. At this writing it is believed that it will stand rougher treatment in shipment without a box to contain it than the ordinary 60-lb. square can boxed. The bail has a large wooden handle so that it is much easier to lift and carry than a 60-lb. square can with its small bail in the top. It has the

further advantage that the whole top is removable which, in the case of granulated honey, makes it possible to remove small amounts with a scoop or trowel. This top, for shipment or storage, is held down against a gasket ring by means of lugs that compress it to a tight seal. The heavy gauge metal, the double seaming at the bottom, and the manner of locking on the top makes it unnecessary to put this container in a box, either in pairs or singly, as in the case of square cans. The lids are furnished with a cap and spout so that small amounts of liquid honey can be easily drawn off.

These containers can be re-sealed a couple of times so that they can be used again. In Canada where this type of container has been used quite extensively the pails are returned and filled again. The author believes it will be wise for the average beekeeper to use for shipment new containers only, or until this type of pail has definitely proven that it can be used the second time.

It should be noted that these 60-pound

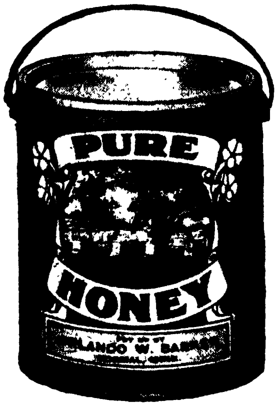


pails before shipment can be used as temporary storage tanks with the lids removed. The scum rising can be skimmed off and the lids put on and then sealed. If the honey is not quite ripe, it can be left in a hot room for some time, then sealed just before shipment.

While many carloads of honey have been shipped in these containers and with the best of satisfaction, the author advises trying only a few at first.

The cost of square cans boxed is about the same as the round containers unboxed.

Honey is sometimes shipped in five and ten pound round pails and square gallon cans in car lots. But all such small containers should be boxed not more than a dozen cans to the box. These smaller packages will go through to destination in good order and are immediately available for retail sales. As a rule, all honey put up in tin pails will granulate. Therefore it is highly necessary to put on the label instructions for liquefying. But honey is never shipped in these smaller containers in small lots unless there is a retail trade at destination that asks for

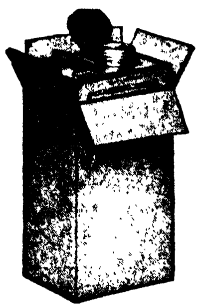


Five-pound round pail.

these smaller packages. While honey in tin pails, five and ten pound and gallon sizes, can be sold in Canada because the trade is educated to granulated honey, the sale of honey in such packages in the United States is comparatively limited. Glass packages, from a few ounces to two pounds, the honey liquefied, as explained under Bottling, have the preference.

Honey by Parcel Post

Some beekeepers do a nice business in sending honey by parcel post to their customers. Special fiber cartons are made to hold 3, 6 and 12 pound square cans. Experience shows that honey can be delivered cheaply and safely in these protected cans. Where one advertiser in the local



paper offers to deliver honey at so much a package, he can develop quite a trade. Prices and particulars regarding these parcel post packages can be obtained of the nearest dealer in beekeepers' supplies.

For further consideration of how to put honey up in tin and glass, see Extracted Honey, Granulated Honey, and Bottling.

New Square Cans Versus Second Hand

A great many times second-hand square cans, especially if they have been used for the shipment of honey, can be used over again. The danger is that, weakened by the strain of banging and slamming in the first shipment, they may leak in the second shipment. Sometimes these second-hand cans are rusty on the inside. While the rust itself does no great harm, it is objectionable to the trade, especially if the rust is on the outside of the can.

Sometimes second-hand kerosene or gasoline cans are used. Unless one is very careful in cleaning, however, the honey placed in them is likely to be ruined. Honey that is dark or ill-flavored may be shipped in such cans if the cans are carefully cleaned and allowed to air out thoroughly before they are used.

To clean, use a handful of unslacked lime to every three or four quarts of boiling water. After it is thoroughly dissolved it is poured while hot into the can. The can is well shaken and afterward rinsed out with clean hot water. Bear in mind that the rinsing water should be boiling hot. The cans should then be placed, with caps removed, where they will dry out.

Even after all precautions have been used for washing out kerosene cans, there is danger that a taint of kerosene will cling to the honey. If so, the lower price at which the honey must be sold would exceed in loss several times what the extra cost of new cans would be.

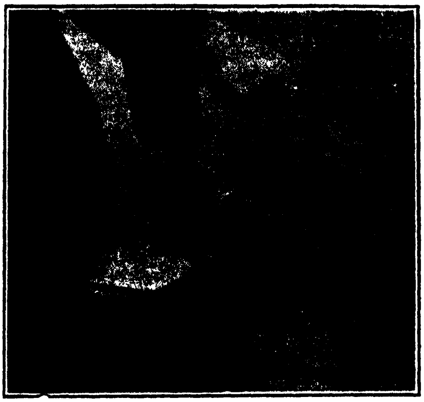
Second-hand cans that have contained syrups of any kind can be used safely, provided they are not rusty on the inside or outside.

Honey in second-hand cans is in very great danger of being sold at a half-cent or a cent less than the same honey in new cans. The difference in cost between the second-hand cans and the new cans is so little that the beekeeper can not afford to be penny-wise and pound-foolish in the selection of his containers.

Second-hand cans can, however, be used in a very limited way for the storage of honey in the honey-house.

How to Convert Second-hand Square Cans Into Storage Tanks

There are two or three ways for accomplishing this; but perhaps the simplest is to take a common hive-tool, cold chisel, or a can-opener and cut out the top of an ordinary square can. The cut



Top or bottom of the ordinary 5-gallon honey-can is cut with the hive-tool and a hammer.

shows how this may be done with a common hive-tool and hammer. After the top is cut out, the folded edges should be pounded down so there will be no sharp cutting edge. A wire bail can be attached to make a honey pail.

CARNIOLANS.—See Races of Bees.

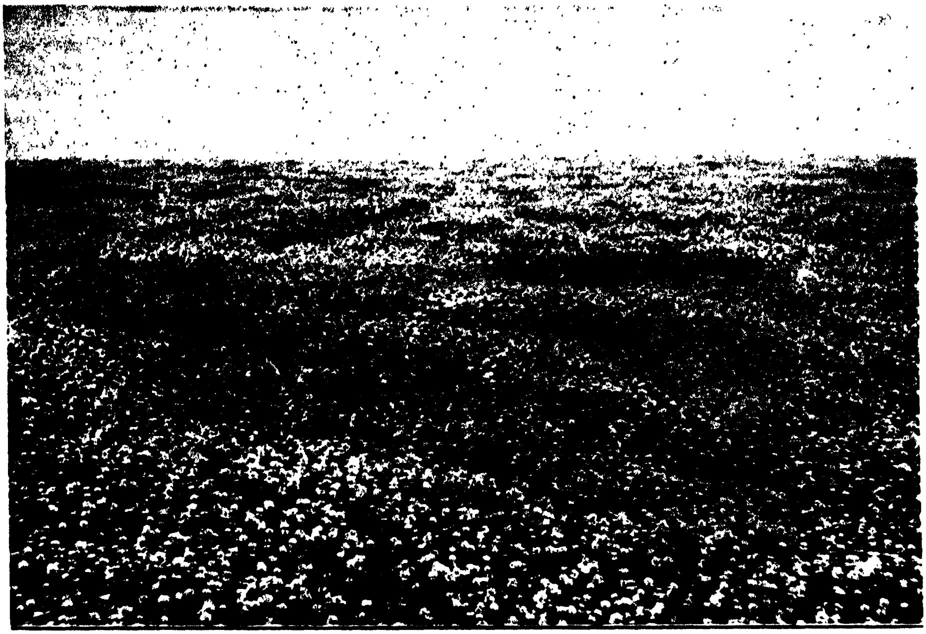
CARPENTER BEES.—See Xylocopa.

CATSCLAW (*Acacia Greggii*, Gray.)—Known also as paradise flower and devil's claws. (See Huajilla.)

The catsclaw is a bushy tree in the southwestern states, with low-spreading branches, attaining a height of anywhere from 15 to 20 feet. It derives its name from the bushy and fuzzy blossoms suggestive of the furry coat of a cat, and the peculiar kind of claws or hooks, shaped very much like the claw of a common house cat. If one tries to push through the bushes or among the branches he will conclude that, unless he "backs up," he may "remain hooked."

The leaves are small and in clusters, while the blossoms have a cottony or downy look.

The tree comes into bloom about the first of May, and yields honey for a considerable time before going out of bloom. In July there is a second crop.



A field of white clover in Iowa.

Like the huajilla and mesquite it grows in the semi-desert regions of Texas and Arizona where it would be impossible to carry on farming without irrigation.

CAUCASIANS.—See Races of Bees.

CELLAR WINTERING.—See Wintering in Cellars.

CELLS, QUEEN. — See Queens and Queen-rearing.

CHUNK HONEY. — See Bulk Comb Honey, under head of Comb Honey.

CLIPPING.—See Queens.

CLOVER (*Trifolium*).—No group of plants yields more or better honey than the clovers.

Some 30 or 40 years ago a failure to obtain a crop of white clover honey was almost unknown. In more recent years intensive agriculture has tended to exclude white clover from cultivated fields and to confine it to the roadsides, hedgerows and pastures. Its place was taken by red clover and alsike clover, but these species in turn have lately begun to disappear. Lands that formerly yielded clover in abundance, in some cases produce it only sparingly, or not at all, and are called by the farmers "clover-sick." The cause of this difficulty was soon discovered to be an insufficient amount of lime in the soil. The clovers will not grow on an acid soil. Alsike requires less lime than red clover, but the time finally comes when the land will not support alsike. When the land was new, or before it was tilled, it contained a larger amount of lime; but constant cropping has largely exhausted the natural supply. Hence the soil is "clover-sick," or requires lime.

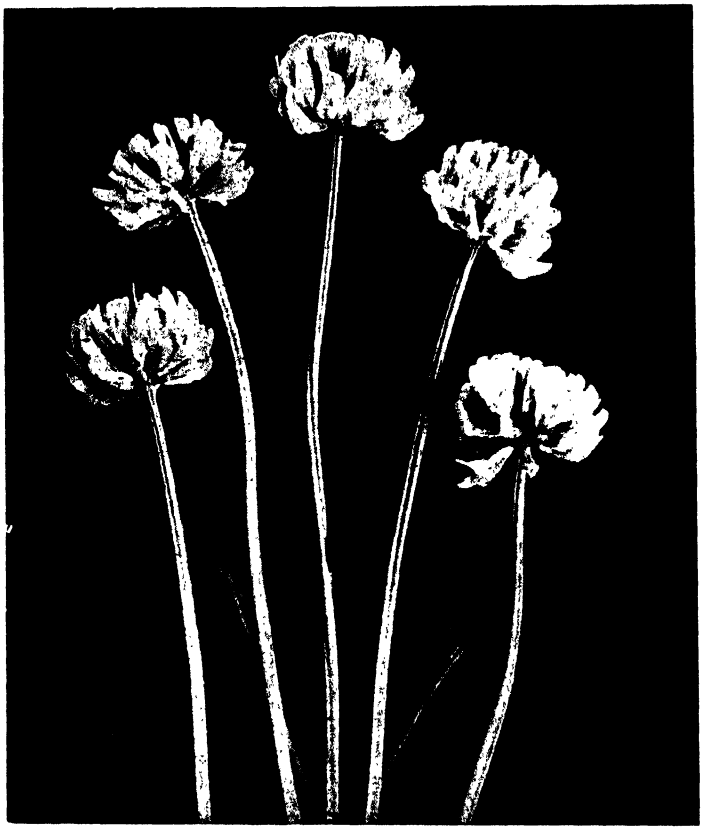
If sorrel is growing on the land, or blue litmus paper placed in damp soil turns red, it may be assumed safely that there is a lack of lime. Beekeepers should carefully inform themselves as to whether the clover fields in their locality are deficient in lime or not. If so, they should endeavor to induce the farmers to get in touch with the nearest experiment station and seek advice in regard to this matter. From 1000 to 5000 or 10,000 pounds of ground limestone may be required to the acre.

The attention of farmers should also be called to the part clover plays in increasing the nitrogen in the soil. On the roots of the clovers there are little nodules or

tubercules, from the size of a pinhead to that of a pea, in which there live multitudes of bacteria. These bacteria are able to fix the free nitrogen of the air in nitrogenous compounds, which after the death of the bacteria the clover plants are able to obtain. The fixation of nitrogen is aided by lime and humus in the soil, and is retarded by an acid soil or one which is compact and not well aerated. The tubercules do not survive the winter, but are formed anew each season.

Since alsike clover requires less lime than red clover, the gradual decrease of lime in the soil has in many localities led to its substitution for the latter. While this has been a great advantage to beekeepers temporarily, it will not prove a permanent one unless lime is applied, since finally the soil will become so acid that alsike will not grow in it. White clover, likewise, is largely dependent on a soil rich in lime, and it has been disappearing not alone because of intensive agriculture, but also because of the increasing acidity of the land. Years ago there was no difficulty in getting annually a surplus of honey from white clover.

WHITE CLOVER (*Trifolium repens* L.).—In the central and eastern states no other honey plant is so universally known as white clover, and white clover honey is the honey *par excellence*—the honey with which all other honeys are compared. It is a delicious white honey of the finest quality. It has the qualities which satisfy the largest number of consumers and at the same time fills most perfectly the demand for table honey of the highest grade. It is given the preference by most purchasers in the eastern states, and the highest praise which can be bestowed on any honey is to pronounce it equal to that of white clover.



White clover blossom—first stage.

The flowers of white clover are familiar to every one since that plant finds a con-

genial habitat in the vicinity of human dwellings. It carpets the lawns, fringes the paths and roads, and is common in the fields and pastures. There are in each head a flower-cluster from 57 to 89 small florets. At first all the florets stand erect, but as the marginal ones are pollinated they cease to secrete nectar and are bent backward and downward against the stem. By preventing useless visits this change in position is beneficial to both flowers and insects. When they expand the flowers are white, but they often turn reddish after they are reflexed. The calyx is less than three-sixteenths inch long, so that not only honeybees but many other insects are able to reach the nectar. Honeybees also often gather loads of yellow pollen, although this is not abundant.

The Secretion of Nectar

The factors controlling the secretion of nectar by the flowers of white clover are very imperfectly understood. In England, Canada, and the northeastern portion of the United States, it is usually a good honey plant, but in France and Switzerland one may travel for several kilometers and not see a bee on the flowers. At Rouen, France, during one day of white clover bloom a hive on scales actually lost 300 grams in weight. In various localities in the United States it is also reported to be almost a total failure at times. One beekeeper says: "As an actual fact, the amount of clover honey is not measured by the quantity of the bloom; for I have seen the fields white with an abundance of it, but only a fair crop. I remember one year when there was a scarcity of bloom, and yet there was a good crop of clover honey. I have also seen fields white with clover, but no honey."

In general the secretion of nectar is not reliable in sections where the mean annual summer temperature exceeds 77 degrees F., as in Louisiana where it makes a vigorous growth; but occasionally, if the summer is cool and there have been sufficient rains in the spring to produce a luxuriant growth, a good crop is obtained south of this isothermal line. White clover is much more abundant on soils where the underlying rock is limestone than on soils derived by the disintegration of sandstones and shales. On soils rich in lime nectar is secreted much more freely than on neutral or acid soils. In southern Minnesota, southern Wisconsin and southern Michigan, where the summers are cool and the soils are of limestone origin, white clover seldom fails to yield a large surplus; but in Illinois a full crop is obtained only about one year in three, and in central Kentucky and Tennesee only occasionally. In the southern states it is of little importance. Scholl reports, however, that white clover yields a surplus in northeastern Texas.

Climate and soil exert a very marked effect on the growth of white clover and consequently upon the yield of nectar. In wet clay ground in regions where the winters are severe, the roots may be much broken and drawn out upon the surface, or the plants may be killed outright by repeated *lifting*, caused by the alternate thawing and freezing of the soil. The destructive work of the frost, however, is much lessened by the natural mulch afforded by the dead vegetation found in waste places and in meadows which have not been cropped too closely. Snow also offers excellent protection; and, when it covers the ground for the most of the winter, clover suffers little or no damage. Winter-killing from freezing in well-drained sandy soils or in warmer climates is practically unknown.

White clover as a honey plant is at its maximum in "the white clover belt," which includes western Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, and Iowa. But it is not equally abundant in all parts of these states, nor are the limits of the belt strictly defined by their boundary lines. In the opinion of Phillips "the best clover territory in the United States is probably northwestern Ohio, northeastern Indiana, Michigan, Wisconsin, and Minnesota, all of which are covered with a heavy deposit of glacial drift, 10 to 1,000 feet deep."

White Clover, How Propagated

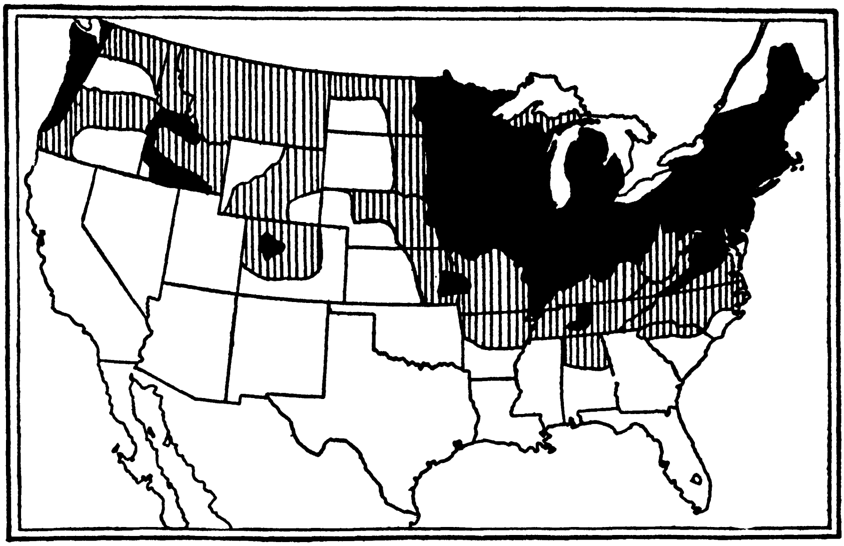
There is no more important or interesting subject to the beekeepers of "the white clover belt" than the life history of white clover, and its problems. The plant is propagated by seeds and by runners which root at the nodes and finally become independent stocks. As in the case of the strawberry, a single plant may in a favorable season cover with its runners a circle of ground two or three feet in diameter. If these new plants winter uninjured they will bloom the following season in the same manner as

strawberry runners. The older plants, as is also true of the strawberry, exhausted by multiplying both sexually and vegetatively, are easily killed by drouth or cold. When the ground is densely covered with an old growth there will be little opportunity for runners to root or seed to germinate. Consequently there may come years when there are few new plants to bloom.

White clover seeded in the spring will produce, if there is sufficient rain, a heavy crop of bloom in July and a fair amount of seed. Much depends upon locality. Clover raised from seed is more valuable for nectar the second season than during the first. (See "Honey Plants of North America.")

Alsike clover.

ALSIKE CLOVER (*Trifolium hybridum* L.).—This species was called *hybridum* by Linnaeus since he supposed it to be a hybrid between white and red clover. It was named alsike clover from the parish of Alsike in Upland, Sweden, where it was first discovered and where it grows abundantly. It is now known as alsike or Swedish clover in Scotland, England, Denmark, Germany, France, and America. It was introduced into England in 1834 and later into this country. It is a very hardy perennial plant adapted to cultivation in a cold climate.



Outline map of the United States, showing roughly the area in which alsike clover is grown. The black area shows where alsike clover is more or less regularly used as a forage or seed crop; the hatched area, where it is rarely grown or only in special places. (From Farmers' Bulletin 1151, United States Department of Agriculture.)

Alsike Clover as a Honey Plant

Alsike clover is far more hardy than red clover and will grow on damp or wet land on which the latter will not grow. It is adapted to moist clay soils and sandy loam soils rich in humus, but it will not thrive in dry sandy or gravelly land. Lime is essential, but less is required than by either white or red clover. In Ontario, Canada, it is regarded as the foremost honey plant, and in many localities it is the only source of honey in quantities. Hundreds of acres are grown in this province exclusively for seed; but there is probably no region in this country in which it produces larger yields than in that of the Great Lakes. From Michigan southward to Ohio there has been an immense increase in the acreage. In perhaps one-half of the fields alsike is mixed with timothy, in one-quarter with red clover, and in the remaining quarter alsike is grown by itself.

It is generally conceded that alsike clover yields nectar more freely, and is a more reliable honey plant than white clover. An acre of alsike has been estimated to be worth two or three of white clover, but this does not appear to hold true in all localities. The honey is so similar that it is doubtful if one can be distinguished from the other. It has been observed over and over again that apiaries in the immediate vicinity of alsike clover will yield more honey per colony than those having access only to white clover even in great abundance. A field of 20 acres of alsike will take care of 50 colonies of bees very well, provided it is supplemented by white clover in the vicinity. The period of bloom of alsike is also much longer than that of white clover, lasting when pastured nearly all summer. While alsike, as a rule, does not yield a heavy second crop, the late bloom is of great value. During the first year it seldom makes a heavy growth, not attaining its full luxuriance until the second and third years.

The fact that alsike clover is replacing the red species in so many localities is of much importance to American beekeepers. Consider how many localities would be literally transformed if red clover were replaced by alsike. Beekeepers should take advantage of this steady movement in the right direction, and, in addition to preaching the gospel of sowing alsike, should offer to pay a part of the cost of the seed.

RED CLOVER (*Trifolium pratense*). —Red clover was pollinated formerly by bumblebees, and is therefore called a bum-

Peavine, or mammoth red clover, life size.

blebee flower. (See Red Clover in "Honey Plants of North America.")

In a favorable season, when there is an abundant rainfall and the flowers of the red clover are fully developed, honeybees can not ordinarily reach all the nectar. Some attempts have been made to develop a permanent strain of red clover bees; and there are strains of Italians that are efficient as pollinators of red clover. The production of a strain of red clover with shorter corolla tubes has also received consideration in the vicinity of Defiance, Ohio. There, it is claimed, is a strain of short-tubed red clover.

Honeybees as Pollinators of Red Clover

Hundreds of reports from localities where red clover is grown have shown that Italian honeybees do gather honey from red clover—not only from the second crop, but from the first crop as well. It is pretty well established now that honeybees of some strains are very important agents in the pollination of red clover. Bumblebees are fast disappearing in the United States, because of the ignorant farmer who destroys them and the protected skunks that destroy their nests. In most localities honeybees are the only agents for bringing about cross-pollination.

A study of the pollination of red clover, made by the United States Department of Agriculture and reported in Bulletin No. 289, published in 1915, substantiates the observations previously made by beekeepers as to the ability of honeybees in cross-pollinating red clover, as will be seen from the following extracts:

> The higher yield of seed obtained in the honeybee cage than in the bumblebee cage may be attributed, at least in part, to the larger number of bees which had access to this clover. However, the ratio of honeybees to bumblebees was no greater in the cages than in the clover fields in the vicinity of Ames (Iowa) in 1911.

In the summary of this bulletin the authors say:

> The honeybee proved to be as efficient a cross-pollinator of red clover as the bumblebee in 1911. When the precipitation was considerably below normal in June, July, and August, 1911, and but few nectar-producing plants were to be found, honeybees collected large quantities of pollen from red clover. In order to collect pollen they must spring the keels of the flowers. In doing this they cross-pollinate the flowers.

In the regions where red clover seed is grown there are usually no other honey plants in bloom during the second bloom of red clover, and beekeepers in these regions know that near large apiaries many more honeybees may be seen working on red clover practically every year than any other insect.

Mr. A. A. Doenges, of Defiance, Ohio, reports that large quantities of red clover seed are produced in his locality, and that honeybees are the only pollinating agent, as bumblebees have disappeared. He is an extensive honey producer and is sure that one-fourth of his crop of honey comes from red clover.

Red Clover Pollination in Colorado

Prof. R. G. Richmond, associate entomologist of the Colorado Experiment Station at Fort Collins, has for several years been carrying on a set of experiments in red clover pollination. In a letter received in 1929 he says: "In this state red clover is not pollinated by bumblebees to any extent. Our pollination is brought about by honeybees . . . We do know that honeybees are doing the pollinating since bumblebees are extremely scarce." Later in a bulletin, No. 392, published by the station in July, 1932, he gives this convincing summary:

Summary

1. Honeybees were found to be carrying red-clover pollen. A large percentage of the bees observed, were active pollinators of red clover. These insects are a major factor in pollination of this plant in Colorado, east of the mountains. Red clover seems to be a convenient and prolific source of pollen for honeybees in some Colorado localities.
2. Honeybees will carry nectar and pollen on the same fielding trip and both in considerable quantities.
3. Insects, capable of penetrating a 13-mesh screen wire, are a minor factor, if an agent at all, in the pollination of red clover at Fort Collins and Rocky Ford.
4. Night-flying insects are not instrumental in red-clover pollination at Fort Collins.
5. The length of the corolla tube apparently has no bearing on red-clover pollination by honeybees.
6. Alfalfa in bloom, does not withdraw the attention of honeybee pollinators from red clover.
7. First-cutting red clover sets a good crop of seed when conditions are such as to be inviting to honeybees.
8. There is a sequence of bloom among the flowers on the head and among the heads on the plant.
9. Corollas of unpollinated flowers remain in flush bloom much longer than those which have been attended by pollinators.

Some work was done at Holgate, Ohio, in 1932 and 1933 under government supervision in co-operation with the Ohio

State University, that goes to show that honeybees pollinate red clover. (See Gleanings in Bee Culture, page 614, October, 1932.)

PEAVINE OR MAMMOTH CLOVER (*Trifolium pratense perenne.*) — As the English name indicates, this is the largest variety of red clover. It blooms principally in the months of August and September. It is an excellent forage plant to plow under for the purpose of reclaiming an exhausted soil. The flowers have the same structure as those of red clover, and probably yield nectar under similar conditions.

CRIMSON CLOVER (*Trifolium incarnatum.*)—Other English names are Italian clover and carnation clover. It is also called annual clover, since if sown in the fall it will form a stand before cold weather, remain green throughout the winter, start again very early in the spring, and mature its seed before summer. It grows wild in southern Europe and in a few more northern localities, and is widely cultivated for forage in Italy, Germany, France, and Great Britain. It was introduced into this country about 1822, and during the last 30 years has been extensively cultivated in the sandy soils of the middle and southern states. In the northern states it is usually killed by the severe winters.

In the southern states it is being introduced very extensively by the farm bureaus and by the extension men. But it can not be grown successfully unless the land is limed. When this is done it makes a very fine and valuable forage crop for cattle and horses, and an excellent bee pasturage. It is being introduced very largely, especially in North Carolina and South Carolina.

Crimson Clover as a Honey Plant

The sessile flowers are in oblong terminal heads 1 to 2 inches long. A field of crimson clover in full bloom possesses great beauty, and passers-by often stop to gather and admire the flowers. It is difficult for one who has never seen an acre of crimson clover to comprehend the beautiful display presented by the broad expense of deep red flowers mingled with the vivid green of the leaves. The structure of the flower is very similar to that of red clover. The corolla tube is 8 or more millimeters long, and, as in the case of red clover, is adapted to bumblebees, which are common visitors to this species. It is likewise much more productive when cross-pollinated than when self-pollinated. At Medina, Ohio, almost as many honeybees have been observed on the flowers as have been seen on buckwheat; and so eagerly did they seek the nectar that, as fields in full bloom were ploughed under, they still continued to fly over the land. In view of the length of the corolla tube it would seem to be impossible for honeybees to obtain all of the ncetar under normal conditions. It is a special advantage that it blooms earlier than the other clovers, filling in the intervals between the bloom of the orchards and that of white clover. The quality of the honey from crimson clover ranks fairly well with that of any other clover.

In fact, the honey from any clover is good. There is so little crimson clover grown comparatively that a strictly crimson-clover honey is unknown in the market. What little is produced is probably mixed with that of other clovers. In any case it would not impair the quality of the honey from any other source.

On the culture of crimson clover see "Crimson Clover: Growing the Crop," by J. M. Westgate, Farmers' Bulletin 550.

COLOR OF HONEY.—See Honey and Its Colors.

COLLOIDAL SUBSTANCES IN HONEY.—The colloidal substances in honey have received little attention in the past from chemists who have investigated the composition of honey. This has been due probably to the relatively small quantities present in honey, and also because of the heterogeneous nature of the colloids themselves. Results of some tests on honey carried out by R. E. Lothrop and H. S. Paine in the Carbohydrate Division of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture indicate that in spite of the relatively small quantities present, substances in colloidal condition play an extremely important part in influencing many of the properties of honey. Th term "colloid," it may be explained, is used to designate substances such as gums which ordinarily are not capable of existing in crystalline form. Colloids are the non-crystalline, "gummy" substances of nature in contra-distinction to substances such as sugar, salt, etc., which are capable of existing in crystalline form.

The quantity of colloids obtained by ultra-filtering honey solutions through carefully prepared and standardized collodion membranes, ranged from approximately 0.1 per cent for some light honeys to almost 1.0 per cent for darker types such as buckwheat. The colloidal material removed from honey by this process is extremely sensitive to heat, comparatively low temperatures being sufficient to cause decomposition and charring of the entire mass. Honey which had been ultrafiltered withstood heating much better than the corresponding unfiltered sample, indicating that the low caramelization point is due in large measure to the presence of colloidal substances. In this connection, it is interesting to note that the turbidity of honey is due almost entirely to the presence of colloidal substances and that, in the darker honeys, a considerable proportion of the coloring matter is present in colloidal condition.

Further investigation of honey colloids has shown that their stability (i. e., their ability to remain in suspension in honey) is due in large measure to electric charges carried by the colloidal particles, thus causing these very finely divided particles to repulse each other and remain in suspension. This electric charge is generally positive in character, although in some honey-dew and tree honeys containing relatively large quantities of inorganic salts the electric charge was found to be negative. It was also found to be possible to adjust the acidity (pH) of a honey solution to a point where no electric charge was exhibited by the colloidal particles. At this point, the so-called isoelectric point, there was a marked tendency for the collodial particles to flocculate and settle out of the honey, leaving it brilliantly clear.

Flocculation of the colloids of honey can also be brought about by the addition of appropriate quantities of bentonite, a colloidal clay, the particles of which, being negatively charged, neutralize the positive charges of the honey colloids, resulting in mutual flocculation of the honey colloids and the colloidal clay and leaving the honey free from turbidity. After removal of the flocculated material by filtration, and evaporating the honey solution under partial vacuum to the original density, a brilliantly clear honey, somewhat lighter than the original in color, was obtained. This "clarified" honey withstands heating much better than the corresponding original honey. This was demonstrated by applying a standard candy test, thus showing the beneficial effect of removal of colloids on the cooking qualities of honey. The clarity and brilliance of appearance of treated honey is also a valuable asset in honey packed in glass containers.

A process such as the bentonite method for removing colloids should be carried out in such a way that no loss of flavor results. Vacuum evaporation of a honey solution results in some loss of flavor, which is undesirable, especially in the case of light, mild-flavored honeys. Experiments are being continued in the Bureau of Chemistry and Soils in the endeavor to apply the bentonite or a similar clarification method without any dilution of the honey.—Nils A. Olsen, Chief of Bureau of Chemistry, Washington, D. C.

COMB FOUNDATION.—The invention of the movable frame by Langstroth, the honey-extractor by Hruschka, the bellows smoker by Quinby, and last, but not least, comb foundation by Mehring, made it possible to keep bees on a commercial scale never before attempted.

Comb foundation is just what its name signifies. It is the base, midrib, or foundation of honey-comb without the superstructure of the cells. If a piece of comb be taken and sliced down on both sides nearly to the bottom of the cells, there will be found the foundation of the comb, with initial cell walls, and hence the name. The comb foundation of commerce is much the same thing except that it is artificial, made of pure beeswax, with walls enough heavier so that the bees can use the surplus in drawing out and extending the cells into completed comb.

Comb foundation is made by passing a thin sheet of pure beeswax between a set of rolls or dies, the surfaces of which have been stamped or engraved in such a way as to give the imprint of the natural base of the honeycomb itself. The invention or discovery, rather, lay in the fact that the bees would utilize this article made by man, and change it into perfect comb inside of 24 or 48 hours when honey is coming in at a good rate.

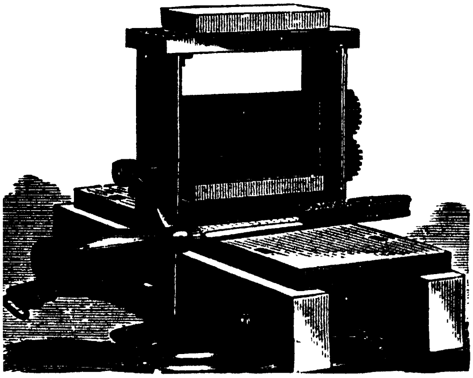
The History of the Invention of Comb Foundation

To J. Mehring, of Frankenthal, Germany, is accorded the credit of having in-

vented comb foundation in 1857; but his product was very crude, having only the indentations of the bottoms of the cells with no cell walls. In 1861 Samuel Wagner, the founder of the American Bee Journal, improved the foundation of Mehring by adding shallow cell walls. This, besides giving the bees wax to build the cells, also strengthened the sheet itself. Up to this time the article had been made between engraved flat metal plates; but Wagner was the first to conceive the idea of turning out the product between a pair of suitably engraved or stamped rolls operated on the principle of a mangle or a common laundry wringer. But, evidently, he never developed the principle.

Foundation Rolls

In 1866 the King brothers, of New York, and in 1874 Frederic Weiss, made



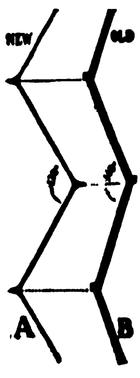
Original Washburn foundation-mill.

foundation rolls; but the product that they turned out from these rolls was very crude. It was not until 1875 that A. I. Root, in collaboration with a friend of his, A. Washburn, a fine mechanic, brought out a machine on the mangle principle that turned out sheets good enough and rapidly enough to be of commercial importance. This old original Washburn machine was so nearly perfect that its product was the equal of that from any cut mill made on a similar pattern today.

About this time, also, or perhaps a little later, Frances Dunham and J. Vandevort, of New York, built rolls that turned out an excellent product. About the same time J. E. Van Deusen, also of New York, built a machine that made foundation having flat bases, and incorporated in it fine wires. While the flat bases were not natural, of course, yet the purpose was to get a thinner base and to use wire. The bees, it is true, would reconstruct the bases, but they apparently did not take to flat-bottomed foundation as well as to the article having natural bases, and it subsequently disappeared from the market. In later years Charles Ohlm, of Wisconsin, built a machine for engraving rolls with angle bases by the use of cutting-knives or gravers.

Early in 1900 E. B. Weed, the man who developed what is known as the "Weed process" foundation, worked out a plan for making rolls using metal type, cast at a type foundry, and of the same metal that is used in printers' type. This original machine developed some defects that were not easy to overcome. Finally in 1918-1919 H. C. Blanchard and H. H. Root worked out the problem, so that it is now possible to make a comb foundation by using die-cast faces that are a perfect duplicate of the bottom of natural comb, having the correct angle in the base. (See cut below.)

It was not possible, by using cutting knives, to engrave rolls so as to give the exact natural base; but it was possible to make a steel die perfect in all respects, and from this cast hard-metal type that would give for the first time in the world's history a comb foundation having a base with the same angles and nearly as thin as in natural comb. The diagram accompanying will explain more exactly. The old engraved or cut face on soft metal is shown in the heavy black line marked B. The new one is shown by the light line with the sharper angles—a difference of 20 degrees. Until 1919 no foundation ever put on the market had a base that the bees did not have to modify, requiring physical energy on the part of the bees, to say nothing of the time consumed in reconstructing the base.



Drawing illustrating the difference between the cast type mill foundation A, and the old foundation, B. The latter has the thicker base, the flatter angle, and the unavoidable distortion.

The old-style foundation made from the engraved rolls was not accurate, because it was impossible to cut or engrave the die faces on a soft metal having a curved surface that

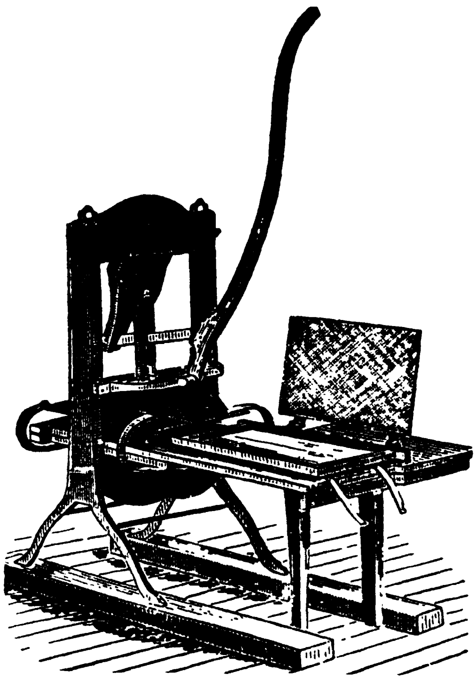
would be as symmetrical and accurate as the bees make them and at the same time hold their shape. A metal that is soft enough to cut or stamp will wear rapidly, and at the same time flatten out so that angles will become still more at variance with those of natural comb. By using a cast-type face, made of a metal so hard that it can be neither cut not stamped, it is possible to get away from the wear and crushing so troublesome in the old cut mill. The distortion of the base on the soft metal will very quickly become greater; and so after a very short time the foundation, never perfect at the start, becomes less and less suited to the requirements of the bees.

Comparative tests in the hive show that the bees appreciate having foundation that they do not have to modify. In making these tests, strips of foundation, old milling and new, were put side by side in the same frame in the center of a strong colony. It was apparent that the bees in most cases would draw out the new or natural base foundation much more readily than a foundation which had flattened or distorted angles, as shown in the diagram at B.

Flat-plate Foundation-machines

About the time that the Root-Washburn comb-foundation rolls were being developed, the Given press using flat die-plates was brought out. Some few preferred the product from that machine because, as they said, the foundation could be made right on the wires of a frame, and because the bees could work the wax a little more readily. The reason for this was that no press at that time (in the early 80's) had been made that could exert as great a pressure as that given by a pair of rolls; and the result was, there was a large waste of wax in the bases. The foundation made good combs, and the bees worked it readily; but the individual sheets were too expensive as compared with the product turned out on rolls by the manufacturers, and so the Given press disappeared from the market.

In the early 80's various flat-plate machines were brought out. Among the number was one using flat dies made of plaster of Paris. By taking a perfect sheet of comb foundation it was possible to take off molds in plaster. But these molds would not stand pressure, and therefore it was necessary to pour melted wax over them and close the dies. As soon as the wax cooled the dies were opened and the sheet removed. But difficulty was experienced in getting this cast foundation (for that is just what is was) from the plaster molds. About this time, also,



Given foundation-press.

electrotype plates were taken off from a perfect sheet of foundation—a process that was comparatively simple, and one that any electrotype founder could readily carry through. Various patterns of these copper-faced machines, including the Given, appeared on the market; but the only one that survived at the time was the Rietsche press, made in Germany. A good many thousands of these were sold in Europe; but the objection to it was the waste of wax left in the cell base. None of the Rietsche presses have been sold in the United States.

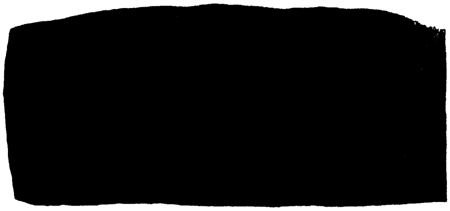
In 1921 The A. I. Root Company built a flat-plate press for making a wood-base foundation. This, like all other wood-base foundation, did not prove to be a success.

Weed Sheeted Foundation

Until 1895 practically all the sheeted wax used in making comb foundation was made by dipping a thin board into melted

wax and then into cold water. Two sheets of wax of the size of the dipping board were thus produced. The thickness of the sheet was regulated by the number of dippings. For thin foundation a single dip was sufficient; for brood foundation, two or three dips were required. But the objection to this was that the wax sheet was thicker at the bottom than at the top. This was overcome somewhat by reversing the ends of the board when dipping.

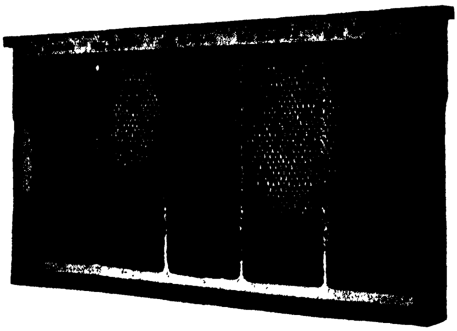
A plaster cast, cross-section view of the old comb foundation showing the flat angle of 140°. At the right the bees have built this same foundation into comb, thinning the base and changing the cross-section angle to 120°.



Plaster casts of (1) natural comb, (2) new angle comb foundation, (3) new comb foundation with one end drawn out by the bees into comb. Notice that the pencil lines drawn through the various bases are all parallel, showing, therefore, that the angles are the same in all three, or the angle as the bees make it. This is important because it saves the bees much work in reconstructing the cells.

The cuts above and opposite show natural built comb and two pieces of comb foundation imbedded in plaster of Paris. After it had hardened a cross section was made. In this way we are able to discover what the bees require in a comb foundation.

Many efforts had been made to produce wax sheets in continuous rolls; but it was not till 1895 that E. B. Weed built a wax-sheeting machine that would turn out wax sheets of any length desired, and of an absolutely uniform thickness. The quality and quantity of this product were such that every manufacturer of comb foundation in the world, with one or two exceptions, has abandoned the old sheeting methods and adopted the Weed process. Probably 95 per cent of all the comb foundation made in the United States turned out by manufacturers is first sheeted on the Weed machine and then put through embossing rolls generally called "comb-foundation machines."

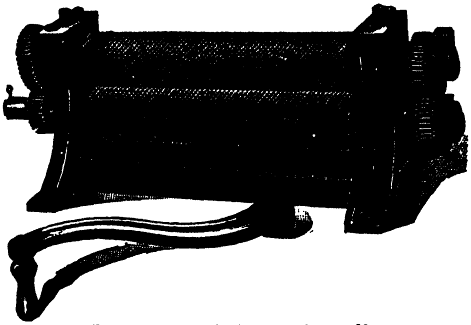


All this foundation was refined by the new process, but only two pieces, the two the bees accepted first, were milled on the new Root type mills. This, with the cut opposite, shows the bees' preference for the natural base.

The new Root type comb foundation compared with foundation milled and refined by the old process.

Foundation Made by Large Factories

The art of making foundation is very complicated, and its manufacture has now drifted into the hands of the large supply manufacturers who are able to turn out a product which for quality and thinness of base is far superior to that made by individual beekeepers. It is a trade in itself to make foundation hav-



Standard comb foundation-rolls.

ing thin bases, because the average beekeeper does not possess the requisite skill to make foundation without wasting wax and ruining the delicate die faces of the comb-foundation rolls.

Great improvements have been made in refining wax, by which the use of all acids, or other chemicals is eliminated. The result of the new treatment is to retain the natural aroma of virgin wax, and at the same time make it more dense and ductile for the bees.

What Foundation Has Accomplished

The invention and introduction of comb foundation has solved many difficult problems of the earlier days. Our forefathers had difficulty, for example, in getting the bees to build combs straight and all worker cells. Before this invention drones were reared in enormous numbers because there was so much drone comb. In modern apiculture only a very few, and those the most select for breeding, are reared. By the use of all worker foundation there will be but very few drones in a hive. The rearing of so many useless consumers not only involved a serious drain on the resources of the colony, but it took the labor of the nurse bees. The elimination of drones by the use of comb foundation materially increases the worker force in a colony, and this has made it possible to increase the actual yield of honey per colony proportionally. (See Combs, subhead, Economic Waste from Poor Combs; also Brood and Brood-rearing and Drones.)

Mention is made of the fact that our forefathers were unable to secure straight combs in their movable frames. The combs, besides having an excess of drone-cells, were more or less wavy, and it was not a little difficult to get the bees to build their product on a straight line and parallel with and directly underneath the top-bar of the frame. (See Frames, also Combs.) V-shaped comb-guides, or narrow strips of wood, the edges of which projected downward, were used as a coaxer to get the bees to build their combs parallel with the top-bar. But every now and then they would build them crosswise, zigzagwise, and every other wise except the right way. The use of even a narrow strip of foundation compels the bees to start the comb on a center medial line beneath the top-bar of the frame; and when a full sheet is used, the comb built from it is not only true and straight, but it will be all worker, as before explained. (See Combs.)

The Evolution of the Section Honey Box

The old box hive of our fathers contained combs built irregularly in small boxes holding from five to ten pounds, the ends of these boxes being glassed. But such a package was too large for retail purposes. The time came when there was a demand for a small package, or one holding about a pound. Comb foundation made it possible for the beekeeper to compel his bees to build combs straight and even in little boxes holding approximately a pound. Without comb foundation, comb honey in sections would be impossible. The invention of foundation paved the way for the one-pound honey section box that sprang into use shortly after comb foundation was introduced on a commercial scale. (See Comb Honey.)

What Size of Sheets to Use in Sections.

Owing to the tendency of foundation to cause midrib in comb honey, some think that using a starter would remove the objectionable feature. They argue that nearly all the comb would have to be natural, and it would, therefore, be delicate and friable like the old comb honey on the farm. But it has been shown that in a majority of cases the natural-built comb will be composed of *store* or *drone* cells, the bees being able to build these larger, heavier cells more readily. Some recent tests seem to show that natural-

built *drone* comb has as much or more wax to the cubic inch than worker comb built from full sheets of thin worker foundation. If the bees, on the other hand, would make their natural comb *all* worker, the resultant comb for delicacy and friableness would be all that could be desired. Drone-comb cappings do not have nearly the pleasing appearance of worker cappings. If for no other reason, full sheets of worker foundation should be used.

The Different Kinds of Foundation

There are three kinds of comb foundation, each having its separate use: viz., (1) super foundation, (2) brood foundation, and (3) reinforced foundation.

No. 1 is used in comb-honey sections of a light weight called "thin super," with an extra thin base and light side-walls. There are two kinds—"thin super" and "extra thin" super. The last mentioned is seldom used now because the bees are inclined to gnaw it down or cut holes in it. Thin super is free from this trouble and does not make a heavy mid-rib.

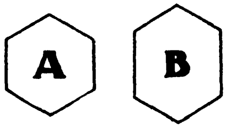
No. 2, or brood foundation, is used in full-depth Langstroth frames, running about eight sheets to the pound.

No. 3 is the reinforced three-ply or wired comb foundation running seven sheets to the pound. While reinforced costs slightly more than the ordinary brood foundation, it is far more satisfactory, and cheaper in the end. Ordinary brood comb will have stretched cells even when built on horizontal wires. This will be explained more fully further on.

Early Efforts to Prevent Foundation from Stretching

Ordinary beeswax, as has already been pointed out, when placed in the form of comb foundation in the hive all summer, is inclined to stretch vertically as well as horizontally. Nature evidently did not contemplate commercial beekeeping. She provided material, however, that answered all practical purposes in a bee-tree or cave. No harm was done if the top row of cells in the combs were stretched somewhat. These the bees filled with honey. If the wax was strong enough to hold the brood, nature was satisfied.

There has been almost endless discussion of the question how to prevent foundation from stretching or sagging in the brood frames while being drawn out. While there is a slight expansion of the sheet horizontally, there is a greater expansion, owing to the effect of gravity, vertically or downward. The greatest stretching, however, occurs during hot weather after the combs are fully drawn, and are filled with honey. The weight of the honey, together with the temperature of the hive, causes that portion of the comb two or three inches beneath the top-bar to be slightly distorted. The upper rows of cells, instead of being exactly hexagonal, will have the two vertical sides of the cells elongated. "A" represents a cell



with all six sides the same length. "B" represents what actually happens in drawing the foundation out into comb. The stretched cells the queen will avoid for egg-laying. They are not right for either drone or worker brood, and so they are filled with honey. Sometimes there is a scarcity of drone-cells. These stretched cells may contain some drone brood, but the emerging drones will be undersized and probably not perfect.

The net result of this stretching or distortion is to reduce the brood capacity of the hive, either 8 or 10 frame Langstroth, about twenty per cent. (See two cuts first column, page 167.) A single brood-chamber of 10-frame Langstroth size is not large enough to accommodate the average good queen in the height of the breeding season, and this distortion or stretching makes its capacity smaller still. Obviously it is impossible for the average beekeeper owning hundreds and perhaps thousands of these hives to enlarge the capacity without going to great expense. Under the head of Building Up Colonies, and under Food Chamber, it will be noted that it is possible to put on a super or an extra hive-body, and this is what is done.

But it would be better to have nothing but worker cells in every comb, and these can be had, as will be shown later on. But the stretching of the cells and the drawing-out of the comb is not the only drawback to comb foundation. Combs built from foundation or built naturally without reinforcement will not stand the ordinary usage in the bee-yard, as will be shown under the head of Extracting. Unless combs are reinforced by the methods shown further on, they are liable to be

broken out in shaking the combs to dislodge bees, or while being extracted in the extractor.

Both for the purpose of preventing stretching of the cells and also preventing the breaking of the combs while in use, various methods have been employed. One of the earliest was to suggest the use of a midrib or re-enforcement of paper, tin foil, cloth, or wire cloth, and later on cellophane. In the olden days, when comb foundation was in its infancy, the paper or cloth was dipped in hot wax and then run through a comb-foundation machine. The product looked like a very nice sheet of foundation, and every hope was entertained that this re-enforced product would solve the problem, and it would had the bees had sense enough to have allowed the artificial midrib to stay intact in drawing cells out of the foundation. But, unfortunately, they had their own notions. They had a disagreeable way of gnawing the wax off from the paper or cloth, leaving portions of the comb drawn out with holes or deep depressions here and there on the surface of the comb. In the rush of the honey flow the bees would sometimes cover these up, but sooner or later they would come back to the midrib fabric and proceed to tear it out by pulling it away, bit by bit. Next wire cloth was tried. While the bees made fine combs on it, it was too expensive.

Comb built on wood veneer foundation, in thin top-bar frame. No sagging, no imperfect cells.

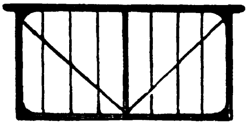
Later on resort was had to thin sheets of veneered wood that were dipped in beeswax. These were likewise embossed with the cells of comb foundation and placed in the hive. The initial tests of the wood-base foundation were very satisfactory. Some very beautiful combs were made from it. But again the bees objected to the form of reinforcement. They would gnaw away the wax down to the wood, leaving imperfect and unsightly combs. Some forty years later attempts were again made to use wood-base foundation. While the comb drawn out was very beautiful in most cases, and while the comb itself was re-inforced more rigidly than anything else that had been tried, the bees later on showed their tendency to gnaw away the wax. The result was that wood veneer foundation was abandoned, like all other attempts with paper and cloth.

When the new cellophane was brought out it was believed that it would solve the problem, as the bees could not gnaw it; but it, too, proved to be a failure.

Along in the early days Van Deusen, of New York, incorporated wires in a flat-bottom foundation. This at the time re-enforced the foundation and the comb; but the foundation itself was very objectionable because the bases of the cells were flat and unnatural. While thousands of pounds of Van Deusen flat-bottom foundation were sold, the product finally disappeared from the market because it took so much time for the bees to reconstruct the cells.

Wiring to Prevent Sag

A. I. Root, who had carefully tested out all the methods that are here given, finally decided in the early 70's that the solution of the problem lay in stretching the wires back and forth across the frame vertically and diagonally from corner to corner. He then imbedded an ordinary sheet of comb foundation on these wires.



This was in 1878. (See illustration.) This was the first successful attempt to make a re-enforced comb rigidly held in the frame. These combs were flat as a board except that the combs were wavy with slight depressions between the vertical wires. They would stand the rough treatment in the extractor or out of the hive. But in A. I. Root's original frame the top-bar was only a quarter of an inch thick. This was supported in the middle by a folded tin bar, the base of which was supported again by diagonal wires reaching to the two upper corners, as shown. But wherever the wires crossed each other, and especially along the line of the folded tin bar, the bees were inclined to gnaw holes or leave a depression.

In the early 90's there came into use

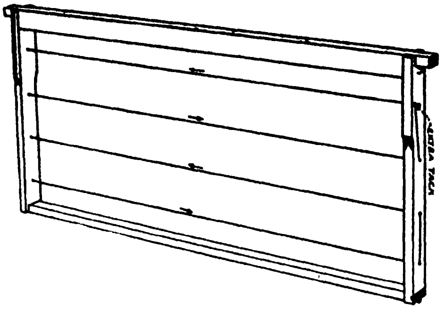


Fig. 3.—The old-style horizontal wiring that was used for a good many years. It made nice beautiful combs, but did not prevent the distortion of the cells within two inches of the top-bar. It is the kind of wiring recommended for Three-ply comb foundation.

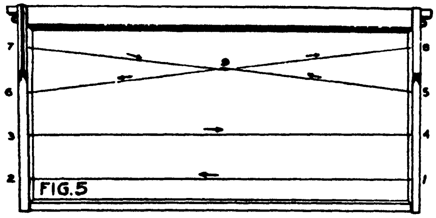


Fig. 5.—This is very good. It will prevent sagging of the foundation, but will not permit of electrical imbedding because the wires intersect at 9.

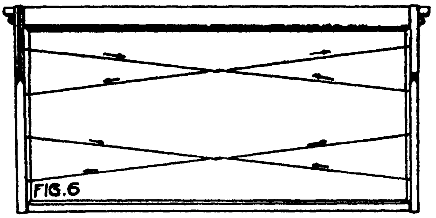


Fig. 6.—This is faulty, like No. 5, and is more difficult to accomplish.

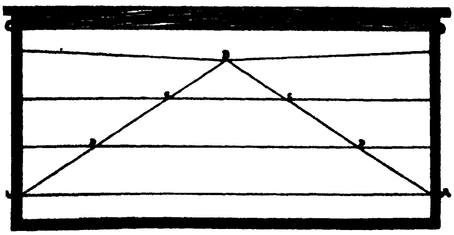


Fig. 7.—This plan has been used very largely in California. It was there that the author saw that brood in combs wired this way would go clear to the top-bar. Because of the difficulty of electrically imbedding on account of the wires intersecting at the tops, Nos. 14 and 15 are recommended instead.

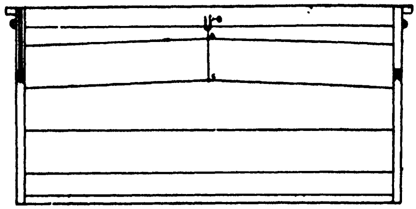


Fig. 8.—This will prevent sagging, but is too complicated, and does not permit of electrical imbedding.

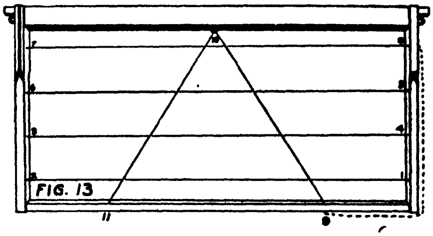


Fig. 13.—This plan is good, but it requires two extra holes in the bottom-bar.

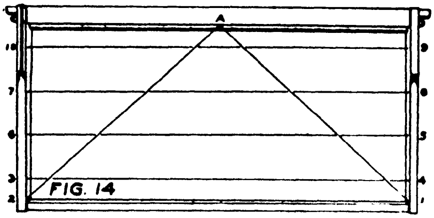


Fig. 14.—This and No. 15 are the plans that the author recommends more than any of the other plans for a foundation not reinforced.

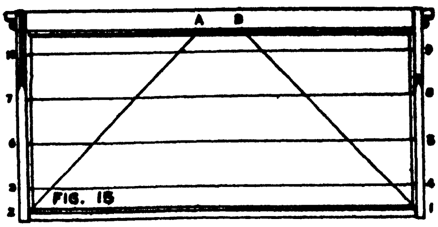
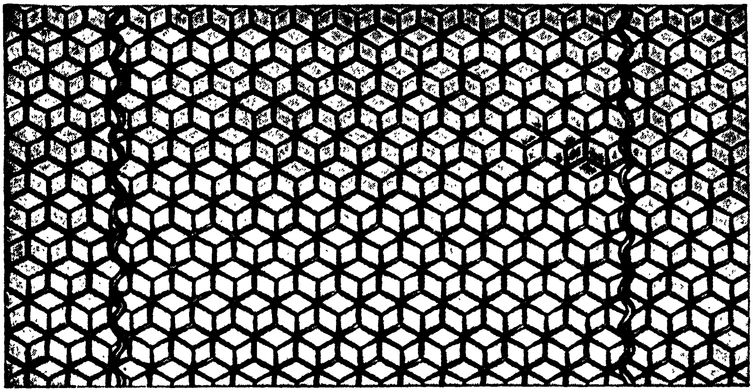


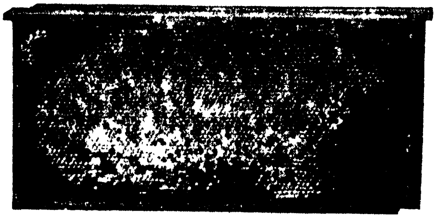
Fig. 15.—This is the same as Fig. 14, except that it uses two tacks or nails for the top support instead of one. Both 14 and 15 permit of electrical imbedding provided the directions are followed.

the thick-top-bar frame. (See Frames and Self-spacing Frames.) While it was possible to bore holes through the top-bar and bottom bar only ¼" thick, through



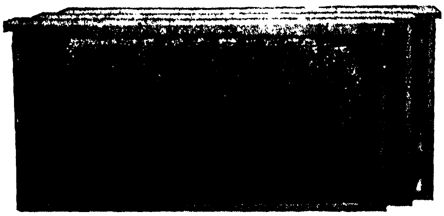
Dadant wired foundation, showing how the corrugated wires are imbedded in the foundation at the factory.

which to pass the wires, it was not practical to do this when the top-bars were seven-eighths of an inch thick. It was finally decided in 1890 to run the wires



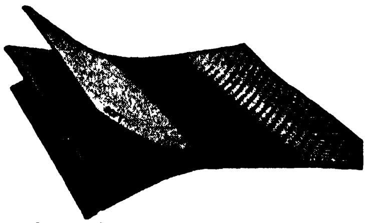
When the foundation is reinforced, as in Three-ply, there will be no stretching of the cells and the brood will go up to the top-bar. Two of these combs equal in brood to three of those below.

horizontally, passing the wires back and forth through the end-bars, as shown in Fig. 3, previous page. This gave very satisfactory combs, flat as a board, and held very firmly in the frame; but it did



When the foundation is not reinforced, the cells of the combs at the top stretch and brood will go up only two-thirds of the way.

not prevent the stretching of the cells. Along in 1918, 1919, and 1920 there arose considerable discussion as to how to prevent the first two inches of the comb at the top from stretching. There were very many ingenious schemes of putting in a cross wiring, as shown on the opposite page. But the scheme that was the most satisfactory is shown in Fig. 15. The frames were wired horizontally, leaving enough slack of wire so as to pass from No. 4 down to 1, up to B, cross to A, hooked over two nails, then down to No. 2 and fastened. But before this was done a sheet of foundation was placed between the horizontal wires and the two diagonal wires. All the slack was taken up when the wire was fastened at No. 2. As will be shown later on, a current of electricity

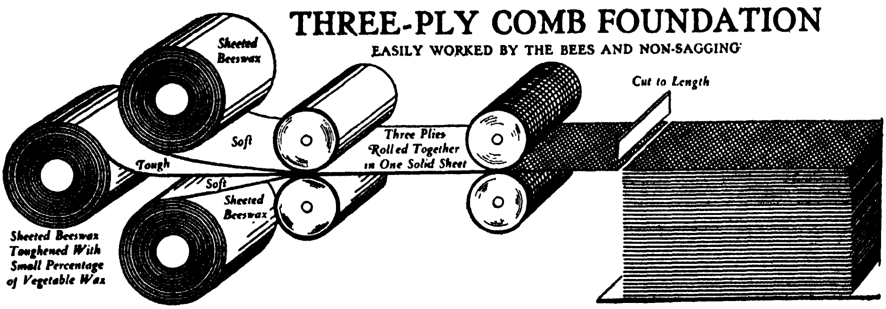


Three-ply comb foundation having middle ply of harder wax.

passing through the wires will imbed them into the sheet, making a well re-enforced frame of foundation. This scheme of wiring was the most satisfactory of anything that had been used. But there was objection to the plan in that the bees were inclined to gnaw holes at the points of intersection of the wires.

Re-enforced Foundation

In 1922 and 1923 two plans for re-enforcing foundation were developed, one by Dadant & Sons and the other by The A. I. Root Co. The Dadants adopted the scheme of Van Deusen, only they used



How Three-ply is made: As its name implies, this famous foundation is made of three sheets of wax rolled together into one. The center ply is not vegetable wax alone but beeswax toughened with a small percentage of vegetable wax to give it strength. The blend is stronger than beeswax or vegetable wax just as nickel steel is stronger than steel or nickel. The two other plies are made of pure beeswax. As the two outer plies form the surface of the midrib and entire cell walls, the bees accept Three-ply foundation readily.

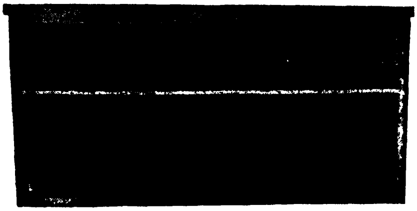


Fig. 1.—Note that this old reinforced comb shows no sagging. The line of cells is practically straight. There are no elongated or distorted cells in the upper part—the entire comb being available for worker brood, from bottom-bar to top-bar.

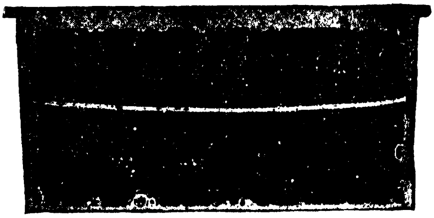


Fig. 2.—The comb built on foundation not reinforced will not stand the weight of the honey or brood in the warm temperature of the hive. The cells in the upper part become elongated and distorted so that worker brood can not be reared in them. The curved line shows the sag.

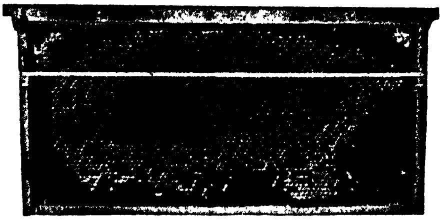


Fig. 3.—The larger worker brood-nest made possible at almost no increase in cost by the use of Three-ply foundation plays an important part in the control of swarming. If there were no other reason for Three-ply this is enough to justify its use.

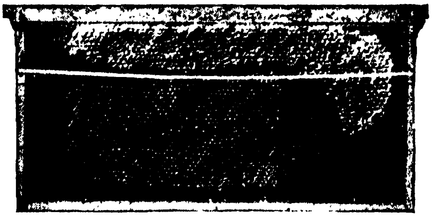
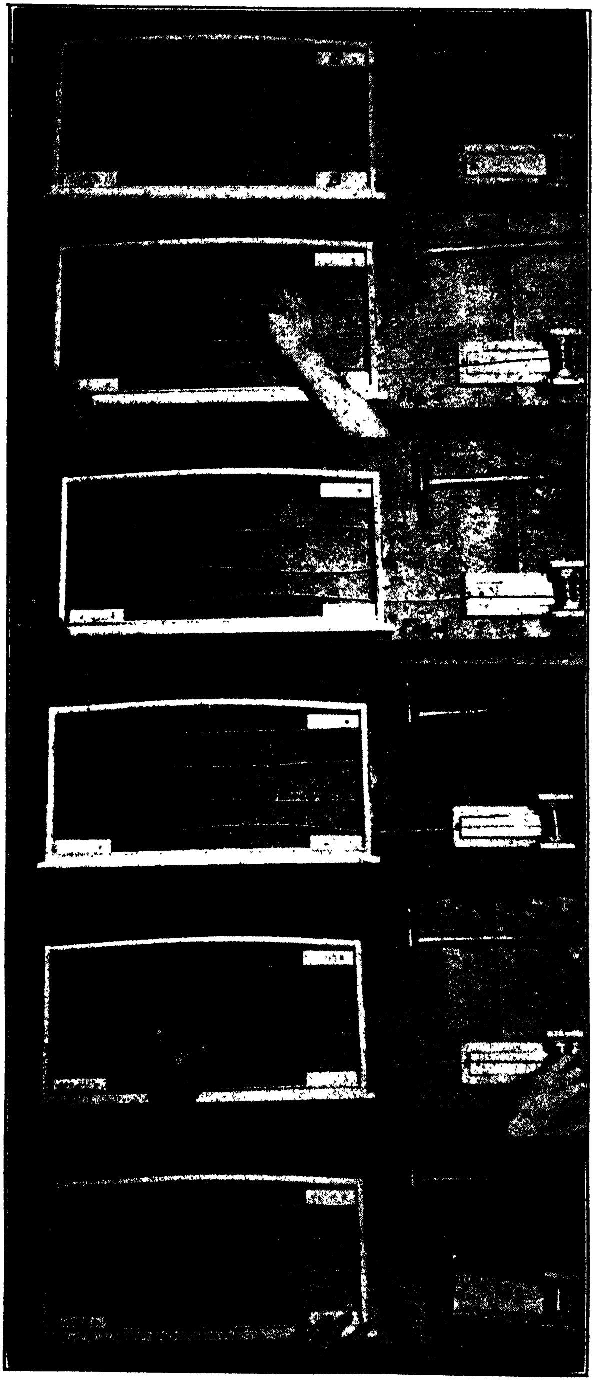


Fig. 4.—The stretched cells in the upper part of the ordinary combs can not be used for worker brood. They are usually used for honey. The restricted worker brood area aggravates swarming and retards honey-storing in supers, hence the need of non-stretching combs.

kinked, vertical wires, incorporating the same in natural-base brood foundation. These wires were placed about two inches apart. The kinks prevented the foundation from sliding down on the wires and at the same time stiffened the wire itself.

Following the Dadants' wired, The A. I. Root Company brought out its Three-ply comb foundation. The center ply consisted of a sheet of pure beeswax re-einforced by a very small percentage of vegetable wax. In the milling a sheet of the hardened wax was put in the center and the three sheets were laminated together as they passed through the mill. (See top illustration on this page.)

Both of these products, the Dadant wired and the Root Company's Three-ply, have had a very large sale. Many beekeepers prefer to use horizontal wires passing through the frame through the end-bars to hold the Dadant wired foun-



How to wire frames with four horizontal wires with simple apparatus.

dation in place. Some think this is unnecessary. While the Three-ply comb foundation will not stretch, it is strongly advised to place it on four horizontal wires, the wires passing through the end-bars.

Both schemes of re-enforcing have furnished some very fine combs and it may be safely said that the day of stretched combs, half drone and half worker, near the top-bar, has now passed. Practically all modern beekeepers now use either one or the other of the re-enforced foundations, and it certainly pays to use them. The experience of the author is strongly in favor of using four horizontal wires for either vertically wired or Three-ply foundation. The cuts on pages 167 and 168 show how ordinary comb foundation, unless re-enforced, will stretch near the top-bar, while the re-enforced especially the Three-ply, will furnish a line of cells that are all worker, and combs flat as a board.

There is a little tendency on the part of bees, when vertically wired foundation is placed on horizontal wires, to make holes at the points of intersection of the wires. But after the first honey flow the bees will fill these holes up, but sometimes with drone brood.

One objection has been made to the use of vegetable wax, on the ground that it would be an adulterant. But the percentage used in re-enforcing the middle ply is very small indeed — just enough to prevent stretching. After the bees have drawn this three-ply foundation into comb, the product when melted reacts as pure beeswax, according to one of the best chemists in the country. Apparently the secretions of the bees act upon the wax in

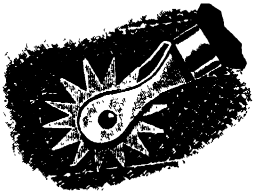
drawing it out in such a way as to change it all into pure beeswax. This could not occur in the case of mineral waxes or of any vegetable wax if large percentages of it were used.

How to Wire Frames

For the straightest combs, foundation should be put in frames within a few days of the time the frames go in the hives. Make up a wiring board as shown on page 169. Lay a frame in place and at three corners nail in blocks A, B, and C. Drive a nail at such a point as to bow outward the bottom-bar of the frame. Mount the spool of wire as shown so that the wire will unwind as needed. Make some crescent-shaped blocks shown at D.

When the bottom-bar of the frame is hooked over the nail the top-bar may be drawn down over the two lower blocks, Fig. 1. This holds the frame firmly.

Now drive a three-eighths-inch wire nail into the right-hand end-bar about

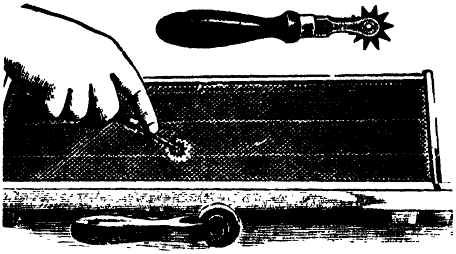


Spur wire-imbedder.

one-half an inch below the upper wire hole, letting it project half way. Drive another one-half inch above the lower wire hole.

Place the spool of wire in position as indicated in the illustrations, letting the wire go away from the spool toward the left, on the under side. Thread the wire also through the eye of a large needle, allowing only about an inch or an inch and a quarter to extend through the eye. You are now ready to begin wiring. The crescent-shaped blocks greatly facilitate the threading of the wire and make the work easy and fast.

When the wire is through the last hole, disengage the needle and wrap the ends of the wire around the upper nail a couple of turns (Fig. 4), then drive this upper nail clear in—thus holding the upper end of the wire fast. Slip the two crescent-shaped blocks out of the wire loop at each end of the frame, and with the hand, firmly grasp the spool to prevent it from unwinding, move the spool, holder and all, to the right, at the same time picking the two middle wires alternately with the fingers of left hand. As the slack is taken up, the wire will be drawn tight and sunk into the wood of the end-bars slightly. If this is carefully done, the wire will never sink into the wood any further, regardless of the weight of honey in the



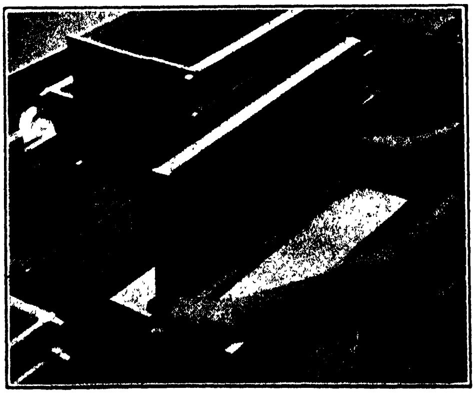
Using spur wire-imbedder.

comb. With the fingers of the left hand or the right, wrap the wire outside the frame around the lower nail in the end-bar (Fig. 6). Drive this nail clear in, thus holding the lower end firmly. Break off the wire, thread it through the needle again, and you are ready for the next frame.

By pulling down on the projections of the top-bar, the frame is easily lifted off the blocks, permitting the bottom-bar to straighten out. This has the effect of still further tightening the wires. Wired frames may be stored indefinitely without deterioration.

Imbedding the Wire

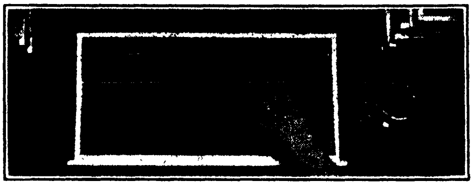
When you are ready to put in the foundation and imbed the wires, carefully un-



Inserting the sheet of foundation in the groove of the top-bar.

pack your foundation, taking due precaution to protect the edges. Get a board seven-eighths inches thick, slightly smaller than the inside dimensions of a frame.

Stand the frame upside down on this board and stand the sheet of foundation in position back of the wires, so the wires are between you and the foundation. By grasping the lower corners of the sheet of foundation with each hand, start the lower edge into the grove in the top-bar. When the edge is started in the groove, give the frame a sharp rap which will jar the sheet down to the bottom of the groove. Then lay the frame down on a ⅞" board, the foundation next the board and wires on top, the frame extending down over the edges of the board.



To Heat the Imbedding Tool

To heat the imbedding tool, any kerosene lamp will answer. Start the heated wheel at the far end of one of the wires and draw it toward you, rolling it down the wire. Put just enough tension on the handle to force the wire half way through the foundation. Do not be discouraged if you run off the wire at first. By the time you are on your second or third frame you can follow the wire rapidly and not run off, each tooth of the wheel depositing a brace of melted wax across the wire, holding it firmly in place. The wire is so firmly imbedded by this plan that you do not need to drive any nails in the wedge in top-bar, if you are using Three-ply foundation. Ordinary foundation is too soft to stand the heat of the hive without being firmly held in the top-bar. With Three-ply this is not essential, provided the imbedding is properly done.

It is possible to wire fifty to sixty frames an hour. This work is preferably done in the fall or winter when time is not so valuable.

One can slip full sheets of Three-ply foundation into the frames and imbed the wires at the rate of 100 an hour.

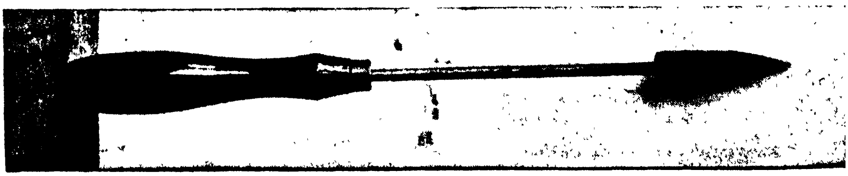
Another tool for imbedding that has found favor with quite a number is a small soldering iron with a fine groove just wide enough to ride over a 28-gauge wire, such as is used for wiring the frames. This little tool, after heating over a common lamp, is drawn slowly over the wires, one by one. As it passes over, it heats the wire, causing it to imbed itself in the foundation as it cools. The tool is heated again, and applied to the other wires in like manner.

Imbedding by Electricity

The most satisfactory method of imbedding wires in comb foundation is by means of electricity; and if one has access to an electric-light circuit, as so many beekeepers now have, the best way is to imbed all the wires at once by attaching the current to the tacks on the outside of one of the end-bars of the frames, around which the ends of the wires are wrapped. The current then flows through all the wires.

Dry batteries may be used for this purpose, but it takes eight to a dozen batteries to heat all four wires quickly, and even then it is a rather hard strain on the batteries. For heating one wire at a time it takes four cells. The trouble with dry batteries for imbedding is that they must be fresh to be efficient, and after a little of this kind of work they are no longer fresh.

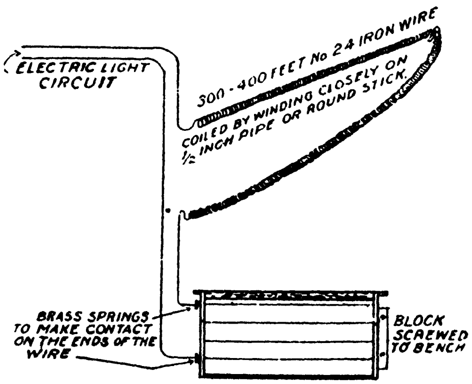
Obviously, with the straight electric-light current, if that were attempted, the wires would be heated red-hot in an instant, or, what is more likely, a fuse somewhere on the circuit would be blown out. The current must first be run through a "resistance" to reduce it, just as steam when run through a steam engine is exhausted, and of much lower pressure thereafter. An electric flatiron put on the circuit in series will furnish the right amount of resistance. In that event the two wires that go to the switch which turns the flatiron on and off, have



A. C. Miller's soldering-iron with the point grooved so that it may be used for imbedding wires.

just about the right amount of current to do the imbedding nicely. If there is no switch, the flatiron may be hooked in on one of the wires, the current going first through the flatiron before it goes through the wires in the frames.

With no electrically heated flatiron available, a resistance coil can be made in a few minutes' time. First, get about 400 feet of No. 24 iron wire. The exact amount can not be given, for the wire varies slightly in size; furthermore, different operators may prefer different amperage to work with. The best plan is to get 400 feet of the wire and then not use quite all of it if more heat is desired. In order to have the wire in convenient form to handle, wind it on a long iron rod, or pipe, the outside diameter of which is about ½ of an inch. Twist the wire around one end of the pipe tightly, so it will not slip with no space between the coils. When it is all wound on, let the wire loosen up, cut the end that was first twisted on and slide the whole thing off the pipe. Hang the coils on nails in the wall or ceiling, being careful that the different lengths of the wire do not touch each other. The electricity after passing

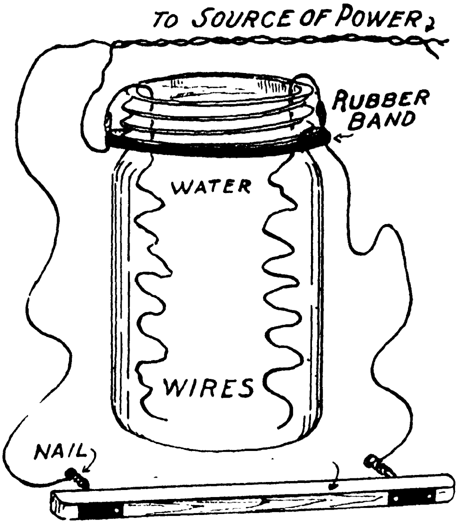


Electrical imbedding device.

through all these coils of wire will be "tame" enough to be handled by any one. These directions are for the standard voltage, 110, found almost universally. It makes no difference whether it is direct current or alternating—one works as well as the other.

Another Method of Reducing Electric Light Current

This simple device is merely a quart Mason fruit jar with two wires or strips of copper or brass extending down into some water. A pinch of salt should be added to allow the current to pass through the water. The current from one wire of the circuit passes into the jar

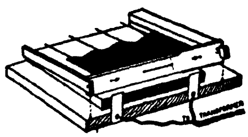


through one electrode, thence through the salt water to the other electrode, then to the imbedder. The other electric wire passes directly to the imbedder. The strength of the current used may be changed by merely changing the strength of the salt-water solution in the jar. It may be necessary to add salt from time to time to keep up the resistance.

Use of Small Electric Transformer

The small transformer sold by electrical dealers, used for imbedding, can be attached to any electric-light socket having 110-115-volt 60-cycle alternating current, and it gives, without the use of batteries, just the right amount of current for imbedding all four wires at once, or only one wire, at the will of the operator. It is used in connection with the imbedding form described elsewhere, and provides a very satisfactory method of imbedding.

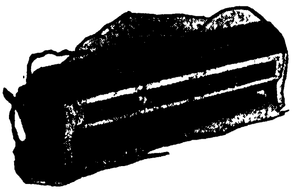
To do the imbedding, take a board



wider than the frame and near one end screw two pieces of sheet brass, which will stick up about an inch. These are to be spaced the right distance apart, so

that if the end-bar of the frame is pushed up against the piece of brass, one tack, around which the end of the wire is wrapped, will touch one brass spring and the other tack the other. For best results there should be a switch for turning the current on and off.

The strands of wire should be on top of the foundation, instead of the foundation on top of the wires. Where diagonal wires are used the sheet of foundation should be put between the diagonal and the horizontal wires. This prevents the bees from making holes where the wires cross. As soon as the current is turned



Resistance coil.

on with the left hand, a light wooden roller, that will just fit inside the frame, should be rapidly rolled across the wax, pressing it down over the heated wires.

Imbedding all four wires by means of electricity, while not particularly easy for the first few frames, is far more rapid than any other method and capable of the very finest work. A good operator that has imbedded a few hundred wires can do the work nicely, but unless one is an expert, one or more wires may not be left exactly in the center of the foundation. Therefore, the single wire imbedder is a surer method when it comes to doing the very best work.

Imbedding One Wire at a Time With Automobile Battery Imbedder

There is on the market a very handy electric imbedding device which uses the

Electric wire-imbedder.

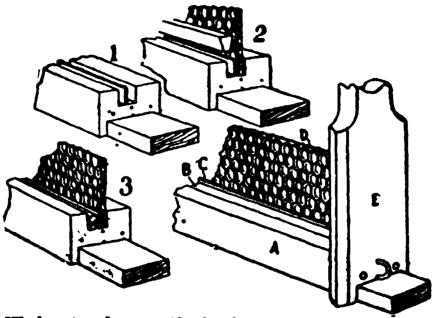
current of an ordinary 6-volt automobile storage battery. From the accompanying illustration it will be noted that this tool imbeds one wire at a time. The current enters the wire at both ends through brass springs attached to the ends of the tool. When in use the tool should be pressed firmly down upon the wire with a form block beneath the foundation and wires, and held just long enough for the current to heat the wire until it has thoroughly imbedded the wire into the wax.

This tool does very rapid work and is just the thing for the beekeeper who has an automobile with electric storage battery, but who has no other source of getting current. This tool may also be used to good advantage from any electric light circuit when used in series with proper resistance, such as an electric flatiron, or with a small transformer or resistance coil.

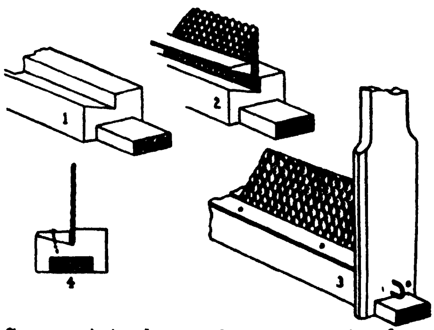
Fastening Foundation to the Top-bars of Brood-frames

After the frames have been wired, but before the wires are imbedded the foundation is fastened to the top-bars, either with the Van Deusen wax-tube or by the plans shown above.

Some of the supply factories furnish the double-groove wedge plan of top-bars because some beekeepers still prefer



Wedge top-bar method of fastening foundation.



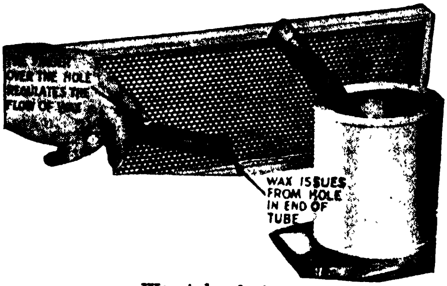
Corner-cut top-bar method of fastening foundation.

them. There is a double groove, one of which is in the center of the top-bar. In this groove is inserted the sheet of foundation, as at D. The wedge-shaped strip

of wood B is then driven into the other groove as far as it will go, crowding the central partition firmly against the foundation. It is very important that it be driven below the surface of the wood, as otherwise it may work out, allowing the foundation to fall out.

Another top-bar, known as the corner-cut top-bar, is used now almost exclusively in preference to the other plan. The loose triangular strip, when toe-nailed as shown in the illustration, grips the foundation firmly. This plan is so good that it is in almost universal use.

There are a few who prefer the melted-wax plan of fastening foundation. Where the underside of the top-bar is plain without grooves or molded edge, this is perhaps the best. The best tool for de-



Wax-tube fastener.

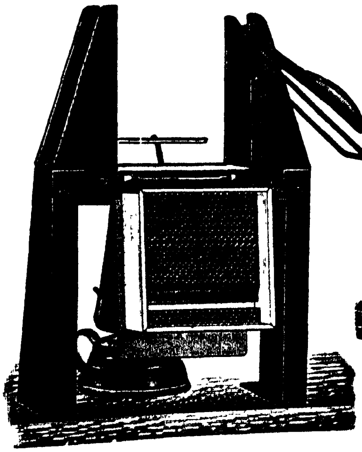
positing a hot stream of wax along the edge of the foundation is undoubtedly the Van Deusen wax-tube fastener. It is simply a tube tapering to a small hole at the apex. On one side is bored another small hole which may be opened or closed with the thumb. When the tube is stood up in a cup of hot wax the air will escape from the upper hole, and the wax flow in at the other small hole at the bottom. The thumb is closed over the upper one, while the tool with the contained wax is raised to the top-bar. Then the thumb is lifted from the upper hole and the point slowly drawn along the edge of the foundation in contact with the top-bar, leaving a fine stream of hot wax to cement it.

Fastening Foundation in Sections

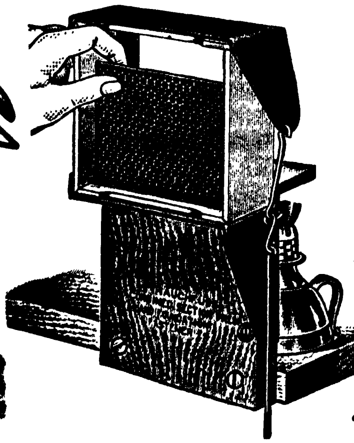
Foundation starters, or preferably full sheets, are used also in comb-honey sections. There are two different ways for fastening the foundation to the sections, by pressure and by melted wax. The pressure method is little used now, because it takes longer and the wax is not so firmly secured to the sections. Moreover, it wastes foundation.

By far the best plan of securing foundation in sections is by the hot-plate method which melts a small quantity of the wax on the edge of the foundation.

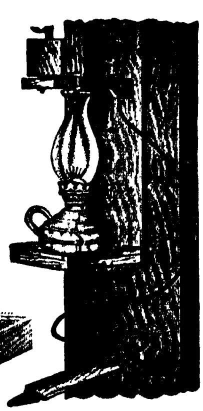
The hot-plate type of fastener, originally devised by Arthur C. Miller, melts a small amount of wax on the edge of the foundation so that it adheres instantly to the wood. This is used more than any other method, principally on account of the neatness and the strength of the work. Moreover, it is the most rapid of any plan. There are a number of these fasteners on the market, all of which do



Woodman combined folder and foundation-fastener. This tool is constructed of metal and does fine work.



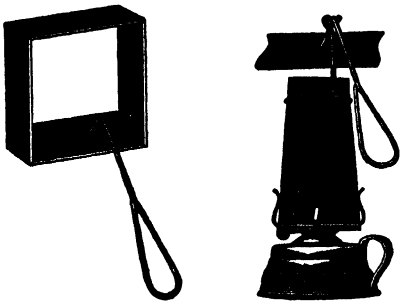
Rauchfuss combined section folder and fastener. One of the simplest and best combined tools on the market.



Lewis foundation-fastener. A simple and rapid outfit.

good work. Some of them fold the sections as well as fasten the foundation.

In most of these hot-plate fasteners the heat is furnished by a small alcohol or kerosene lamp placed directly under the plate to be heated.



Root foundation-fastener.

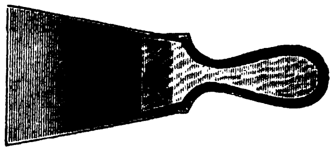
The Root fastener is a small hand tool, which is hung over the lamp to be heated. To use it, a rack should be made to hold four sections as described above, and the section-holder slipped over them. Then, having put the foundation in place and while pressing lightly on the upper edge with the fingers of the left hand, the operator should slide the hot blade under the edge of the wax as it rests against the wood. All surplus melted wax will be wiped off on to the wood so that the foundation will be most firmly attached. The tool will remain hot long enough to fasten all four starters.

Multiplex Foundation-fastener

This is by all odds the most rapid foundation-fastener on the market. With one person folding the sections on the Root section press, and another one to lay in the sheets of foundation, 2000 have been fastened in one hour.

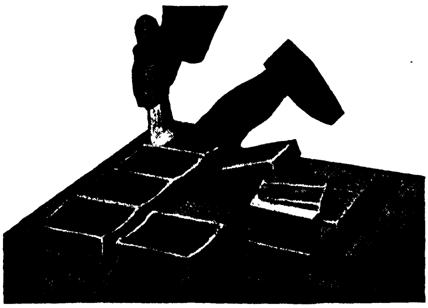
As its name indicates, it is made up of a series of foundation-fasteners embodying the hot-plate principle; but, instead of having a hot plate for each individual unit, there is one hot plate for all of them, in a form of a large putty knife with a wide blade. Each unit consists of a sliding block smaller in dimensions than the inside of the section used. The purpose of the blocks is to hold and push the foundation with its melted edge to the section, where it cools and sticks. For this purpose each block is grooved on the under side and slides on a rail that guides the vertical movement within the section. There are four of these units to a board and usually seven boards to the super.

To get the maximum speed there should be two persons, one folding the sections and the other fastening the foundation with a hot plate. The operation is as follows: The one folding the sections places them one by one as fast as folded over one of the blocks, or individual foundation-fasteners. After putting four



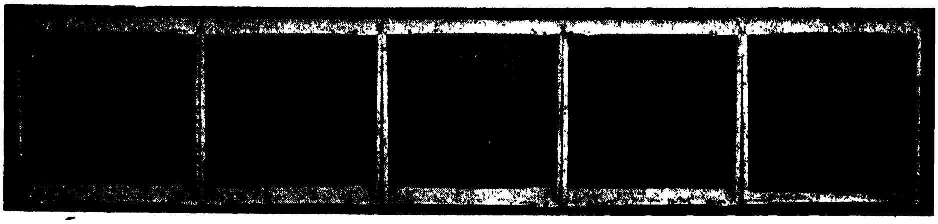
Foundation-fastener.

sections on each of the seven boards, the next operation is to place a sheet of foundation upon the sliding block inside of each section, or twenty-eight in all where the seven boards are used. For still greater speed the same operation can be repeated upon another multiplex foundation-fastener on the other side of the operator.



Multiplex foundation-fastener.

In the meantime, the other person takes up the hot plate, pushes the sheet of foundation mounted on the sliding block toward the hot knife, removes the knife, and then pushes the foundation against the top of the section where it instantly cools. This he does with the same hot knife, without re-heating, to every one of the twenty-eight sections. He next takes a section-holder, slips it over four sections, picks up the four sections in a body, and puts them in a super. He likewise fills up another section-holder and puts that in the super, and so on until he has the super filled. This saves rehandling the individual sections



The different methods of cutting foundation for the sections.

and when the work is done the sections are in the super.

The sliding blocks mounted on a rail insure accurate and rapid work. Foundation that slides on a block that is immovable will not be accurately or as quickly placed. The foundation itself, therefore, will not be centrally fastened, which is very important in order to insure an even filling of the honey on both sides of the section.

Starters vs. Full Sheets for Sections

In the illustrations under Comb Honey, Appliances for, showing the supers, only narrow sheets (or starters) are shown in the sections. The expert comb-honey producer will never be content with a starter. He will buy his foundation of such size that he can cut it to suit his own individual notions. Some cut it in sheets one-fourth of an inch narrower and half an inch shorter than the inside of the section. It is then fastened to the top, as shown previously, with any one of the several styles of foundation-fasteners. Others cut the sheets in the shape of a letter V; still others use half a sheet.

Many prefer to use two pieces—a large one secured to the top, and a strip about ⅝ inch wide fastened to the bottom. The larger sheet is so cut as to reach within ⅛ or ¼ inch of the bottom starter when in place to allow for stretching.

During the subsequent process of drawing out, the bees will make one complete comb, which is fastened to the top and bottom. Where only a starter or even one large sheet is put into a section, the finished comb in some instances may be fastened only at the top and part way down on each side; but when the bottom starter is used in connection with a large sheet of foundation, there surely will be a fastening at the bottom as well as at the outer edges. The result is a comb fastened to all four sides, one that is neater in its general filling, will command a higher price; and last, but not least, a section that will stand shipping. A nice super of sections with combs not fastened at the bottom is liable to arrive at destination in bad condition—many of the

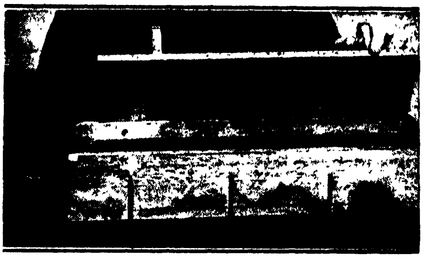


Fig. 1.—Long sheets of foundation laid in the box ready to cut. (The distance between the saw cuts determines the size of the starters.)

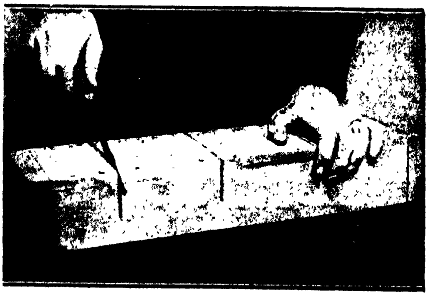


Fig. 2.—Box turned over for cutting. Use sharp thin knife wet with soap suds, and cut on drawing stroke only.

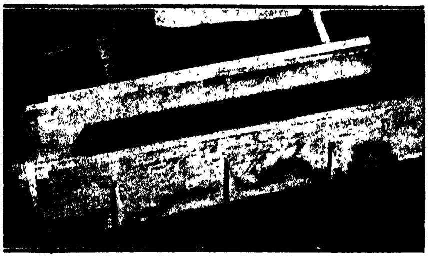


Fig. 3.—The box reversed to original position with foundation cut to size ready to take out.

combs broken out. It is always advisable to use a bottom starter or full sheets.

A few beekeepers advise cutting the foundation so it will just neatly fill the section on all four sides. A section is then slipped over a block a little less than half its thickness so that, when one of these just-right-sized sheets of foundation is laid on the block, the foundation will be perfectly centered in the section. With the Van Deusen wax-tube the sheet is then secured to all four sides by the stream of hot wax. While this plan is good, it is expensive from the standpoint of labor and time.

A plan that some prefer—the one that furnishes a very nice comb honey, is the scheme of having the section-blanks grooved about one-eighth inch wide and half the depth of the section on a medial line running from end to end of the blank. Squares of comb foundation cut slightly larger than the inside dimensions of the section are slipped into the groove before the section is folded. The foundation should not be cut so large that the sheet will buckle after the section is folded.

Neither melted wax nor hot plate—in fact, no heat of any kind—is needed to hold the sheet in place. The work of inserting the sheet is quickly and neatly done, and at the same time the foundation can expand slightly in the groove while being drawn out, provided the sheet is not cut too large in the first place. This, like the other plan, gives almost perfect combs, but is expensive.

It should also be mentioned that there is one difficulty—that of cutting the sheets of exactly the right size. If one has never used this method, he should cut two or three trial sheets and try them out first. When the sheet is cut right for the inside of the folded section there should be a slight amount of end and side play to allow for, a slight expansion that necessarily takes places when the sheet is drawn out. When the right size has been determined on, a wooden form should be made as shown in Figs. 1, 2, 3, on previous page, so as to cut the sheets exactly right.

The best arrangement for cutting the foundation is the miter-box. This device can be quickly made by almost any one, the construction being plain from the illustrations. The box should be placed on a table with the saw-cuts down as in Fig. 1, and from five to twenty sheets of foundation laid in, care being taken to see that the ends are even. Then the cleated board should be put on top of the sheets of foundation, and the box turned over so that it rests on the cleats, as shown in Fig. 2. For cutting, a keen-edged butcher-knife should be used. It need not be hot, if kept well lubricated with soapy water. The knife should be held at an angle as shown, and moved rapidly but lightly back and forth, cutting only on the drawing stroke. If the saw-cuts are carefully spaced and the whole box put together in a square workmanlike manner, the sheets can be quickly and accurately cut.

Experience shows that when the sheet of foundation fills the section a much more perfect comb honey is produced than when there is a large sheet at the top and a small one at the bottom, and certainly better than when a starter is used and fastened at the top only. If the right methods of production are employed, when these full sheets are used the combs will be even, well filled out, without an open corner. Some strains of bees, if crowded for room, will sometimes run the filled cells of honey clear to the wood, without leaving any so-called "pop-holes," or, more exactly speaking, a line of unsealed cells next to the wood on the sides and bottom.

COMB HONEY.—While all honey in the comb is what may be called "comb honey," yet the term as commonly used refers to small squares of comb, built in frames of wood technically called section honey-boxes, or "sections" for short. These may be full sized holding a pound, or may be miniature holding an ounce or more. The latter is described further on. All references to comb honey, whether in the market quotations or in the ordinary literature relating to bees, are understood to apply to the article built in sections. (See page 182.)

Cut Comb Honey

In more recent times there has been put on the market cut comb honey neatly wrapped in cellophane paper. The combs are cut in squares of various sizes from shallow extracting frames. The drip is then removed by placing the cut pieces in an extractor and throwing it off by centrifugal force, or by allowing them to stand on coarse wirecloth trays in a warm atmosphere until they drain dry or nearly so. The pieces, square or oblong, and ranging in size from two ounces to ten or

twelve ounces, are neatly wrapped in the transparent cellophane.

These cut combs in water-proof cellophane wrappers look very attractive and in some markets the smaller packages sell like hot cakes. A "hunk of honey" in its natural container weighing 2 ounces at 10 cents is very tempting to the housewife. She tries it out and then will buy the larger sizes.

It would seem that this form of comb honey should revolutionize the comb honey business and possibly when the difficulties are overcome it may do so.

In 1920 and for several years thereafter the publishers of this work sold to the Pullman Car Company, fancy restaurants, hotels and high-class groceries, what was called individual comb honey. Each chunk of about 1½ ounces was wrapped in paper and then enclosed in a small carton. The comb honey was cut in small squares and allowed to drip for 24 hours and then wrapped. The product seemed to have a bright future because it was just right for one serving on a Pullman diner or in a restaurant or hotel. Carloads of it were sold and then it began to come back as unsatisfactory. "It has gone back to sugar," they said. Then it was discovered that the dry smear of honey on the cut edges of the little combs would granulate and this granulation once started would penetrate into the comb.

There was another difficulty. Producing a fine grade of sealed white honey from thin foundation in shallow frames was a fine art—more difficult than producing nice combs in sections. To cut these little squares from sections—four to the section—was not practicable either. It was too expensive. A further account of the matter was described in Gleanings in Bee Culture for December, 1923. The A. I. Root Company finally abandoned the whole proposition because of the granulation trouble and because it was doubtful if the cut combs could be produced and sold at a profit.

When the new cellophane wrapper was put on the market the cut-comb proposition came to the front again. The honey shows off much better than in the paraffined paper, but there still remains the difficulty of granulation. In the larger sizes of the cut combs, the wraps must be put in cartons and these equal the cost of sections.

If the cellophane wrapped cut comb honey is consumed within three or four months after it is offered for sale it will have a good sale. Those who sell the product, should not oversell the dealer. The latter should keep it on display until it is sold; never let it remain on the shelves until it granulates. If these precautions are observed there may be a future for cut comb honey.

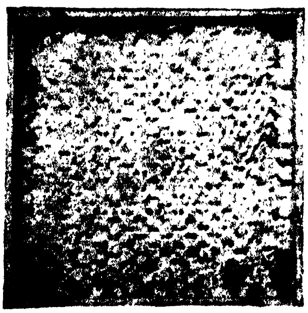
Chunk Comb Honey

In the southern states there is another article called chunk or "bulk comb honey". The combs are built usually in shallow extracting-frames, and cut out in various-sized chunks that will slip into tin buckets or glass jars. The spaces between the combs and around them are filled with a good quality of extracted honey. Bulk or chunk comb honey has the advantage that it does not require as much skill to produce it as the ordinary comb honey in sections; neither is it necessary that every piece of comb be as perfect as to capping, filling, or shape. In localities where there is any suspicion of manufactured comb honey, bulk comb honey is readily sold.

A very serious objection to the use of bulk comb honey in the northern states is the danger of the liquid portion granulating. When this takes place the whole will have to be melted in a wax-extractor, even though the comb honey is not granulated.

Comb Honey Versus Extracted Honey

When the extractor was first invented in 1865, it was supposed that nothing



but honey out of the comb would be sold for the reason that it could be produced more cheaply. But our best connoisseurs now know that even our very best extracted honey seldom has the fine delicate aroma of honey that is held in the comb, just as nature gives it to us. Comb honey holds the flavor and the delicate aroma

of the individual flowers from which it was gathered much better than after it is removed from the comb. The flavors of honey, it is said, are given to it by ethyl alcohols that are very volatile. It follows that, when the honey has been removed from its original container and exposed to the air, it loses some of its flavor, especially if it be heated. (See Extracted Honey, Bottling Honey, Colloids in Honey, Science of Honey, and Granulated Honey.) If ever a majority of consumers prefer comb honey, it will be because to them it has more flavor, and because, probably, the crushing of the delicate cells in the mouth gives the eater a certain degree of satisfaction since he has something to chew. Extracted honey, on the other hand, is swallowed, while comb honey is masticated, or chewed, as food should be. Of course the little pellets of wax, after the honey has been eaten, are generally expelled. To some this very accumulation of wax in the mouth is an objection, and many will be found who prefer extracted honey, because they prefer to have something they can chew on bread and butter and biscuit, without having wax mixed with the food.

Comb honey has been shown by Professor Hawk, the great food specialist, to contain vitamins. By referring to the article Vitamins in Honey it will be shown that these are an inscrutable something that makes life and growth possible, without which the average animal or man would die in a comparatively short space of time. While it has not yet been proved that extracted honey contains vitamins, it has been shown that comb honey does. For a fuller examination of the subject, see Vitamins in Honey.

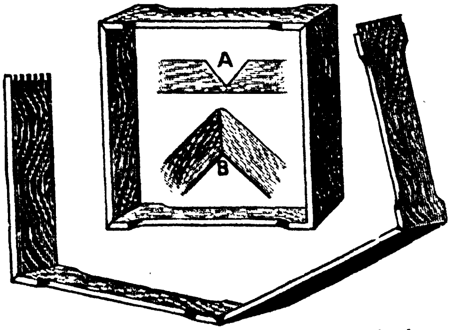
Unfortunately, many commission houses and honey-dealers refused to handle comb honey because of the amount of breakage and leakage and the tendency to granulate after cold weather sets in.

So long as it is admitted that comb honey has a little finer flavor than the same honey out of the comb, beekeepers should foster the demands of all classes of consumers. When it is remembered that comb honey brings more than extracted, it goes to show that there are thousands of consumers who prefer honey in that form, even if they have to pay double price.

Comb Honey Not Manufactured

In the early 80's the statement was made that comb honey could be manufactured—"combs made out of paraffin, filled with glucose, and capped over with appropriate machinery". This canard went like wildfire over the country; and even to this day there are some who believe that honey in sections is manufactured, because it is unlike the honey they saw on the old farm. Except in a very small way it is impossible to make honeycomb as perfect and delicate as the bees do. On a commercial basis it is an utter impossibility. Dies *could* be made that would press wax in a semi-melted condition in the shape of a honeycomb. So far, so good; but it would be impossible to make any dies that will *free* themselves from the comb after it is pressed into shape without tearing the comb to pieces. Any mechanic or die-maker knows that the idea is utterly absurd. Even if it were possible to construct the combs, it would be impossible to fill them with glucose, and equally impossible to spread a film of wax over the filled cells that would come anywhere near imitating the appearance of comb produced by the bees. Any consumer who has a suspicion that combs in sections are manufactured, has only to look over a dozen or more sections at any grocery. He will find no two of them alike. If combs were built from dies they would all look alike, as do the common rough-faced cement blocks which are made in one mold. But a comparison of any two boxes of comb honey will show that bees make each section different from all others. The attachments at the sides of the sections vary, as well as the surfaces of the cappings. (See Honey Exhibits.)

COMB HONEY, APPLIANCES FOR.—In the early history of beekeeping, most comb honey was produced in glass



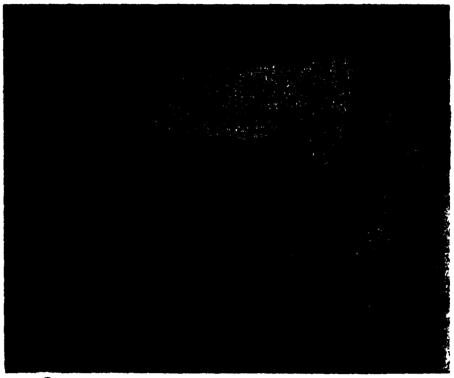
boxes. These were about five inches square, fifteen or sixteen inches long, glassed on both ends. They were not

altogether an attractive package, and were never put upon the market without being more or less soiled with burr-combs and propolis. As they held from 10 to 15 pounds of honey each, they contained a larger quantity than most families cared to purchase at once. To obviate these and other difficulties, what is popularly known as the "section honey-box" was invented, holding a little less than a pound.

That was what was wanted—a small package for comb honey. Thus was accomplished the introduction not only of a smaller package for comb honey, but one attractive and readily marketable. The retailer is able to supply his customer with a small quantity of comb honey without daubing, or fussing with plates. The housewife, in turn, has only to lay the package upon a plate, pass a common table knife around the comb, to separate the honey from the section proper, and the honey is ready for the table, without drip.

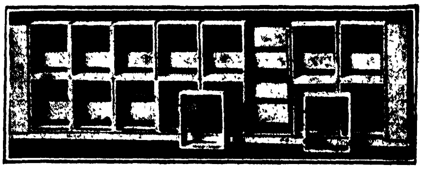
What Size of Sections to Use

In the early 80's there were a good many varieties and sizes and styles of sections on the market. There were the two-pound prize sections, the half-pound,



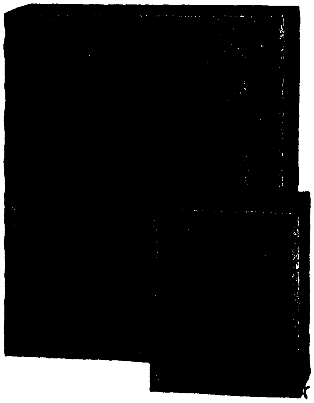
and three-quarter pound; but in later years sections have been reduced to practically three styles; viz., the 4¼x4¼x1⅞ beeway sections, the plain 4¼x4¼x1½, and the 4 x 5 x 1⅜ plain sections. Each of these three holds a scant pound of honey, section included; but under the federal net-weight law (see Labels) and most state laws it is not permissible to include the square of wood around it. The section must be sold in weights from 10 ounces for the lightest to 14 ounces for the heaviest. While it might be desirable to have something holding an even pound, yet no two sections will run exactly the same weight. (See Grading Comb Honey.)

While the sizes mentioned above are in almost universal use, there has de-



Individual Section, 2x2½x1⅜.

veloped in recent years a demand for miniature sections, 2 x 2½ inches, holding about two ounces of honey, enough for one person, for restaurant, hotel, and dining-car trade. Four of these sections occupy the space of a 4 x 5 section, or 128 for a standard size super with standard section-holders for the regular 4 x 5 sections. An expert comb-honey producer in a good flow can often get fancy prices for these little sections that are just right for a single customer. Where there is only one call for comb honey at a restaurant it is necessary to cut out a small portion from a full-sized comb and leave the rest to stand on a plate several days before it will all be used.



Regular and individual size of section of comb honey.

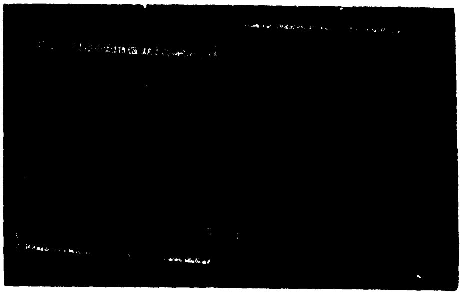
Tall Versus Square Sections

The standard section for many years has been and is 4¼ inches square, but, notwithstanding, during all this time, some beekeepers, principally in New York, have been using a section taller than broad.

Some of the reasons that have been urged in favor of the tall sections are as follows:

1. Weight for weight, and for the same thickness of comb, a tall section looks larger than a square one.

2. By long association we have come to like the proportion of objects all about



Comparative size of tall and square sections of the same weight.

us that are taller than broad. Doors and windows of their present oblong shape are much more pleasing than if square. Nearly all packages of merchandise, such as drugs and groceries, are oblong in shape.

3. A greater number of tall sections holding approximately a pound can be accommodated on a given hive surface.

4. A tall section will stand shipping better, because the perpendicular edges of contact of the comb itself are greater than in a square box.

Glassed Sections

Glassed sections were simply sections of comb honey with squares of glass fitted in between the projecting sides of the section. The glass was held either by glue, tin points, or paper pasted over the top and bottom of the section, and lapping over upon the glass a little way. When the section was sold to the retailer, the glass was included in the price of the honey. Of course, the producer could afford to sell glass at the price of the honey per pound; but under the federal net-weight law this is prohibited. On account of the fact that the producer has to pay the cost of the glass, glassed comb honey has practically disappeared from the market.

Pasteboard Cartons for One-pound Sections of Comb Honey

While sections with glass panels have been practically eliminated from the market, comb honey in paper cartons is becoming more and more popular. In some cities a definite ordinance requires that all food packages be sealed to keep out insects, and especially flies, that carry

Regular Carton.

the germs of disease. It is evident that legislation of this kind will go from city to city and from state to state. But if there is no legislation the housewife sometimes has trouble with a section of honey breaking and leaking over her groceries when delivered. She will thereafter buy her comb honey put up in neat cartons that specify the exact weight of the honey, not including the section, as it is not allowable to sell honey by weight, section included. The paper cartons are comparatively cheap and can be given away with the honey. The glass protects the honey, but is too expensive to furnish with the honey.

Several attractive designs of cartoned comb honey are now on the market; and

Window carton.

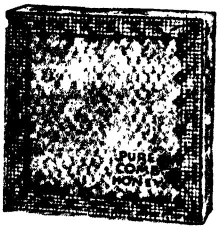
the fact that the demand for comb honey in this shape is growing, even where there is no legislation requiring sealed pack-

ages, shows that not many years hence comb honey will have to be put up in that form, if for no other reason than to shut out the typhoid house-fly.

Since the advent of cellophane, window cartons have come into very general use. As the name indicates, it is a regular standard comb honey carton with the front cut out. This opening is then covered on the inside with a sheet of cellophane neatly pasted in place. This container not only protects the whole section of comb honey but allows the prospective purchaser to see just what he will get. Putting a nice section of comb honey in a carton without the window looks like an attempt to cover up something that is below standard.

Cellophane Wrapped Section Comb Honey

Some of the prettiest section comb honey on the market is cellophane wrapped. Sometimes the cellophane wrappers are decorated with appropriate printing. At other times it is plain. In either case, front and back of the section itself can be seen.



After a little practice and by closely following directions, one can make both faces as tight as a drum. The folded edges can be moistened with water or paste, and sealed. Some prefer to use the stickers, "Eat Honey," to hold the edges down.

Where comb honey is put on display at fairs it is customary to use decorated cellophane wrapped comb honey. It makes a better display than window cartons. The latter are much to be preferred to hand out to a customer who has her market basket or bag filled with other articles having sharp corners. In the case of general honey exhibits, it is desirable to use a variety of containers in glass, cellophane, and tin to avoid sameness. First premiums are usually based upon the artistic variety and so placed that the light will show through the packages. (See Honey Exhibits.)

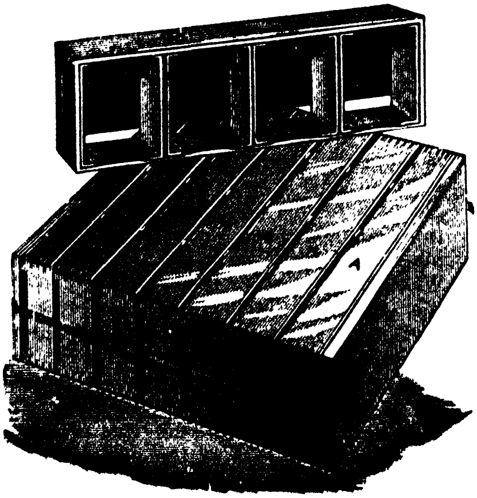
For hints on marketing see Extracted Honey, Bottling Honey, Peddling Honey, and particularly Marketing Honey, found in their alphabetical order.

Devices for Holding Sections While Being Filled on the Hive

Sections can not very well be placed on the hive to be filled by bees without some sort of arrangement to hold them. There are a score of different sorts of wide frames, racks, trays, boxes, clamps, all of which possess some special features. It would be impracticable to show all of them; but for the sake of illustrating some principles it may be well to mention some of those that have been used most largely.

What was known as the double-tier wide frame was perhaps the first device for holding sections in the hive. This consisted of a frame of the same inside depth and length as the ordinary brood-frame, but of the same width as the section, eight sections to the frame. It was used very largely for a while, but in the course of time it was discovered that it had several objectionable features. First, a whole hiveful of them gave the bees too much capacity to start on; and, as a consequence, this discouraged them from beginning work. Second, they did not permit tiering up to advantage.

The Doolittle surplus arrangement consisted of a series of *single-tier* wide frames



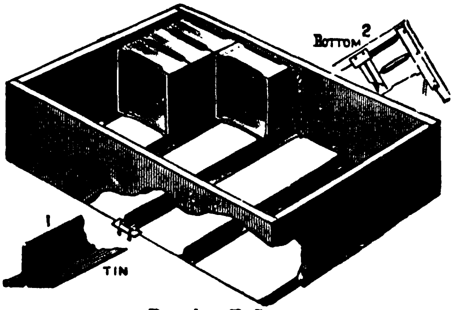
Doolittle's single-tier wide frames.

having no projections to the top-bars, although shallow wide frames have been made with such projections. Both the double and single tier wide frames had

the merit of protecting the surfaces of the sections from travel-stain and bee glue.

T Super

The T super at one time was one of the most popular forms of section-crates, and a few prefer it to anything else. It is so



Regular T Super.

named for the T tins that support the sections. The tins are folded in the form of a letter T inverted, such construction making a very stiff and rigid support. This appliance takes separators very nicely, the separators resting on the T tins.

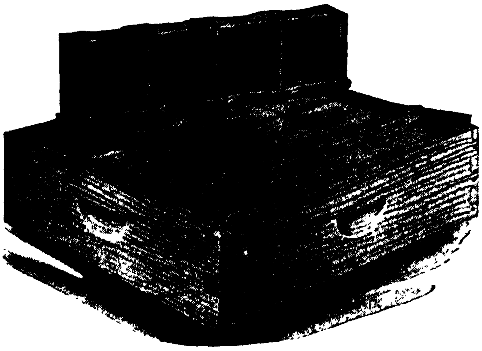
Some, like Dr. Miller, preferred to have the T tins rest loosely on a little piece of strap iron, or bent staple, both for convenience in filling the supers, and in emptying the same after the sections are filled. But there were others who objected to loose pieces, and preferred the super with stationary tins, the tins being nailed to the bottom inside edges of the super.

But the T super has its objections. If the sections are inclined to be a little out of square, or diamond-shaped, when folded, they will not be squared up in the T super unless an extra set of T tins or strips of wood are used to fill up the gaps between the rows on top. And, again, it is not practicable to alternate the several rows of sections. Sometimes, in a poor honey flow, it is desirable to move the center row of sections to the outside, and the outside to the center.

Supers with Section-holders for Beeway Sections

The dovetailed super with section-holders for beeway sections is the form of super that has been, perhaps, used more largely than any other. It is a sort of compromise between the old-style wide frames and the T super. It consists of a series of section-holders that are open at the top. Each holder is supported at the end by a strip of tin nailed on the inner edge of the ends of the super.

Four sections in each section-holder are held snugly and squarely in position with



$4\frac{1}{4}x4\frac{1}{4}x1\frac{7}{8}$ Beeway Section Super.

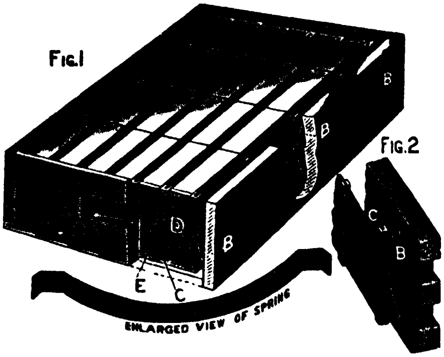
no spaces between the rows of sections as in the case of the T super. When beeway sections are used the bottom-bars of the section-holders are scored out to correspond with the beeways. Between the rows of sections is dropped a wooden separator, as shown at D.

Super Springs

In the illustration of the Hilton super, it will be noted that thumbscrews are used to crowd a follower up against the sections. In the other form of T super a super spring between the side of the super and the follower performs the same office. Indeed, this spring is used nowadays in nearly all modern section-supers.

There is no denying the fact that in any form of super arrangement the sections and separators should be squeezed together to reduce accumulations of propolis. The objection to thumbscrews or wedges is that if the sections in a super become swelled by dampness, the rigid screw or wedge becomes stuck and this sticking makes it hard to remove the sections. If the joints of the sections have been moistened to prevent breakage when the sections are folded, when the super is put on the hive there is a slight shrinkage. This shrinkage makes more trouble than swelling, for the contents of the super become loose. Of course, the bees improve the opportunity to crowd a line of propolis in all the cracks.

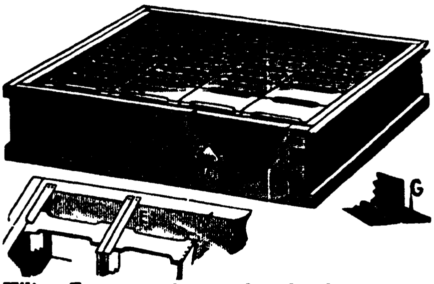
To remedy all this trouble the steel super spring has come. Its pressure is constant. It adapts itself to any swelling that may occur, and equally adapts



Super-springs.

itself to any shrinkage, so as to press the parts together at all times enough to prevent the bees from crowding in propolis.

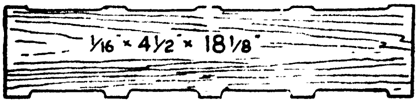
In the illustration it will be seen at B, B, B, that a spring is crowded vertically between the side of the super and post of the fence. When a follower is used two springs (one at each end) are crowded vertically or diagonally between the side of the super and the follower. Some use only a single spring at the middle of the follower.



Hilton T super, using wooden thumb screws in place of super spring.

Separators

In connection with appliances for holding sections in the hive, there is a device known as the separator or fence. These



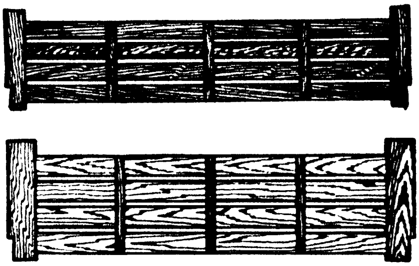
Separator.

separators are put in alternation, one in a place between the several rows of sections. Each separator consists of a strip of wood or metal a little less in width than the height of the sections, and in length equal to four sections standing side by side, or the separator may be a fence made of the same size, but consisting of horizontal strips. The purpose of the separator or fence is to prevent the bees from bulging their comb from one section to another. Without them the sections or combs will be irregular in weight and unmarketable. Some will be too lean, while others will be so fat that their surfaces will be bruised by coming in contact with other sections when they are put into a shipping case for marketing.

Since the net-weight law went into effect (see Labels; also Grading Comb Honey) unseparatored or comb honey can not be graded satisfactorily. The law has in effect made the use of separators imperative.

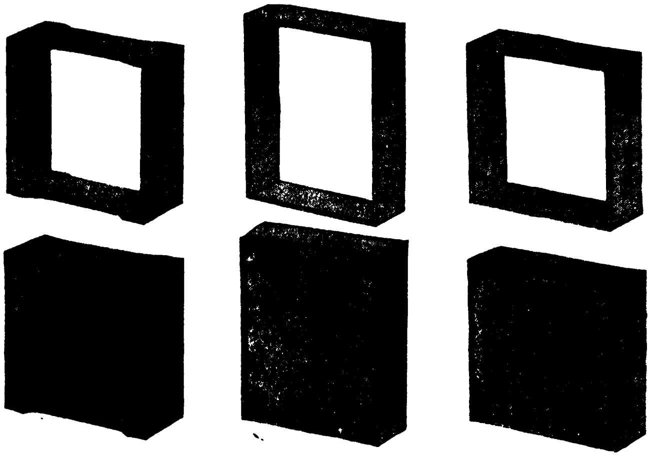
The Fence and Plain-Section System

The sections and section-supers shown heretofore have been of the beeway type. Brood-frames, when in the hive, must be placed a bee-space apart; so also must the sections. Almost the first honey-boxes that were introduced had the bee-space cut out of the top and bottom of the sections themselves, so that they could be placed directly in contact with each other



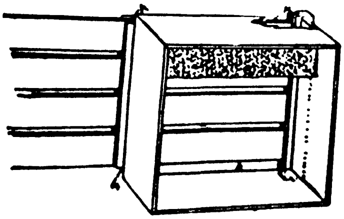
Fence separators for plain sections.

or the separator. This kind of section continued almost up to 1897, when there was introduced a section without beeways, having plain straight edges all around. This had been used for some 10 or 12 years previously by various beekeepers who found it to be in every way satisfactory. But plain sections (even width all around, without beeways) necessitate some scheme for holding them a bee-space apart while on the hive. Accordingly, a separating fence was devised, having transverse cleats at regular intervals on both sides, binding the series of slats together—cleats so spaced as to come opposite the uprights in the sections. It will be seen that the fence system provides for a narrower section,

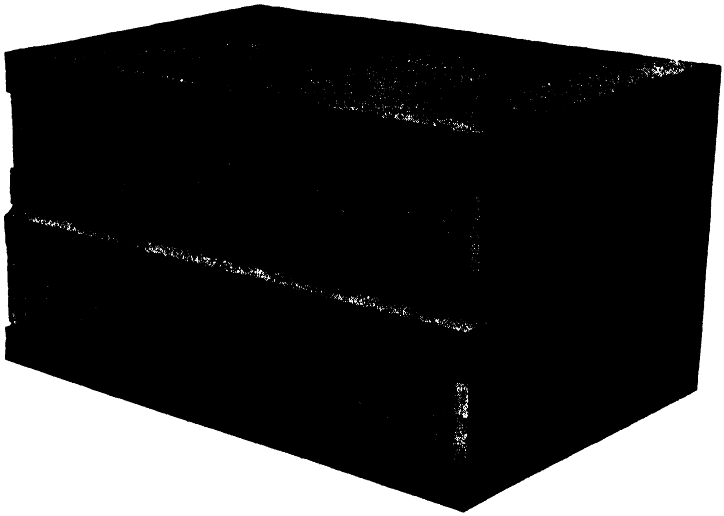


Beeway and plain sections.

and yet this same section holds as much honey as one ⅝ inch wider, because the extra width is taken up by the thickness



of the cleats on the fences, as shown at A, A, A, in cut above, or what would be in the old section two beeways of $\frac{3}{16}$ inch each. In the cuts at top of page there are specimens of beeway sections and no-beeway, the last being generally termed plain sections. The plain save a little wood, and consequently take somewhat less room in shipping-cases. The twelve and twenty-four pound shipping-cases can be made somewhat smaller, because it is not necessary to have each comb bee-spaced apart in the marketing cases, as while on the hive. The plain straight edges of plain sections offer special advantages in the matter of scraping. There are no insets, often roughly cut (as in beeway sections), to work into and around with a scraping-knife. A single sweep of the knife on each of the four edges will re-



Shipping-cases with beeway and plain sections.

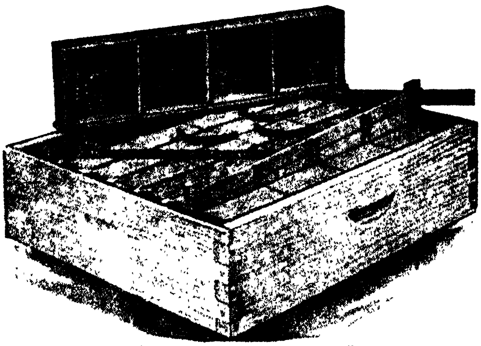
move the propolis, or, better still, if the blade of the knife is long enough, one can scrape two edges at a time. Weight for weight, and of the same filling, a comb in a plain section looks fuller than one having beeways. The illustration at bottom of previous page shows beeway sections in one shipping case, and plain sections in the other. (Plain sections in upper case.)

The fences are made of a series of slats having a scant bee-space between each two slats; and as the cross-cleats, or posts, are ½ inch shorter than the length of the section, the beeway is very much wider. Instead of being a narrow opening through the top, as in the old section, the opening is *clear* across the top, and part way down and up each of the sides. This gives the bees freer communication, and, in consequence, has a tendency to reduce the size of the corner holes in each section.

The largest demand is for the regular 4¼x4¼ two-beeway sections, notwithstanding that the plain sections make a slightly better display on the market. The plain sections are much better for the new cellophane wrappers because there are no beeway openings to interfere with a smooth round corner of fold.

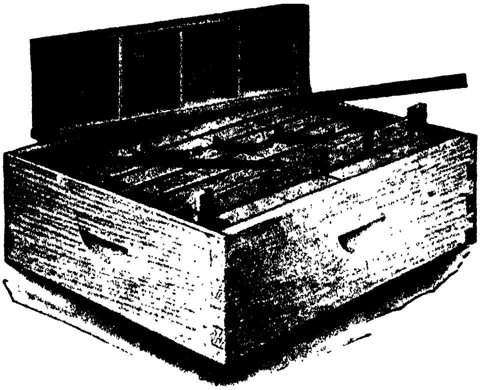
Supers for Plain Sections

In the main, supers for plain sections differ very little from the section-holder super already shown and described for the old-style sections. The section-holders themselves are the same width as the sections. Between each two rows of sections in section-holders is inserted a fence, the end-post of the fence resting



4¼x4¼x1½ Plain Section Super.

upon the strip of tin nailed on the bottom inside edge of the end of the super. An additional fence is inserted on the outside of each outside row of sections, because it was demonstrated by S. T. Pettit that a perforated divider, or what is exactly the same thing in principle, the fence, when placed between the outside rows and the super sides, will result in having those outside rows of sections filled, in many instances, as well as those in the center. The reason of this is that it places a wall of bees on each side of the



4 x 5 x 1⅜ Plain Section Super.

fence, between the comb honey and the super side; and these walls of bees, so to speak, help to conserve the heat so they can draw out the comb and complete the sections on the outside as well as in the center.

COMB HONEY, TO PRODUCE.—In order to secure comb honey the colonies must be very strong—that is to say, the hives must be fairly boiling over with bees—so strong, indeed, that some of the colonies will be inclined to swarm as soon as the honey flow starts. But of this, mention will be made further on.

There is not much use in trying to produce comb honey if the colonies are only two-thirds or one-half strength. In order to bring all of these up to honey-gathering pitch the reader should turn to the general subject of Building Up Colonies. Be sure that the directions that are given are carefully followed. Assuming that this has been or will be done, it is also important that there should be the proper proportion of bees of flying age—that is, fielders. A colony, for example, might have enough bees, but an insufficiency of bees old enough to go to the fields. Many a beginner fails right here. The bees should not be younger than 10 days or two weeks. This will require that eggs

that have been laid to produce bees for the field should be laid from a month to six weeks ahead of the expected harvest.

If it is not practicable to build up the colonies by uniting or strengthening them with package bees (see Package Bees); or if it is desirable to run for both comb honey and extracted, the medium colonies may be left as they are, and run for extracted honey, and those of proper strength run for comb honey. The weak colonies—those of two and three frame size—should be united to the medium-strength colonies; or better still, should be strengthened early by adding a three or a five pound package of bees without a queen.

The medium colonies can be built to proper comb-honey pitch without uniting, provided the weather conditions are such that the bulk of the eggs can be laid from a month to six weeks ahead of the harvest. (See Building Up Colonies.)

Colonies that are very strong in the spring will build up faster, relatively, than the weaker ones; and these can sometimes supply frames of emerging brood and bees to weaker colonies as explained under Building Up Colonies.

In order that the colonies may build up properly in early spring, they should be well housed—preferably in double-walled hives. If they are in winter packing-cases, as described under Wintering Outdoors, leave the packing on until settled warm weather has arrived. Cool or frosty nights will quickly penetrate the walls of hives having only a single-board thickness. This necessarily cuts down the brood-rearing, and consequently reduces the amount of honey, either comb or extracted, that will be secured.

There should also be a liberal supply of stores in the hives the previous fall, not only to prevent starvation, but to make brood-rearing possible. If the supply is scant, the amount of brood and bees in the brood-nest will be correspondingly small, and then it may be necessary to resort to feeding.

It is much better to give a colony a food-chamber of natural stores rather than to feed syrup that is artificial without the minerals, protein, and other elements found in honey. While syrup is fine for cold weather, honey is far better for brood-rearing. (See Food-chamber.)

Having gotten the colonies up to comb-honey pitch, it will be found that some of them, as soon as the harvest opens, will be inclined to swarm. There will be some other stocks that will make no effort to swarm at all. These should be carefully noted, and queens from them should be used for breeding. The swarming nuisance can be very materially reduced by breeding from the queen whose colonies keep on storing honey without swarming. (See Swarming.)

Just as the harvest opens, or a little before, as may be shown by the combs being whitened and bulging near the top, the entrance reducing blocks should be removed or the hive should be lifted up on four blocks placed between the hive-body and bottom. It has been proved that the giving of a large amount of bottom ventilation in this way will check swarming to a very great extent. This ventilation should be supplied a little before the harvest opens, to prevent queen-cells in colonies that are not inclined to swarm, and discourage the building of such cells in colonies that show a disposition to swarm.

Swarming may also be discouraged by giving early a super of extracting combs, and, after the bees are started in this, substituting a super of sections. Extracting-combs may also be put in the side of a comb-honey super, as illustrated further on, or partially built sections from the previous season, called bait sections, may be used. A couple of these placed in the center of each super on the hives will do much to discourage swarming and get the bees up into the super.

Brood-chamber Should be Filled With Brood

Another important requirement in comb-honey production is that the brood-chamber be well filled with brood at the beginning of the honey flow, thus making it necessary that the bees begin work in the supers at once to provide a place for the incoming nectar. While the same condition is desirable in extracted-honey production, it is not so essential as in comb-honey production, since the giving of a super of empty extracting-combs constitutes a strong invitation to the bees to "come up stairs" and expand their work into the supers even though there may still be some empty comb below. To a certain extent, the bees must be forced into comb-honey supers by a lack of room in the brood-chamber for the incoming nectar. Too often in comb-honey pro-

duction the honey flow begins before the brood-chamber is filled with brood, and if storing is begun in the brood-chamber and honey is sealed down close to the brood, the bees usually enter the supers reluctantly, being apparently satisfied with the snug and thrifty condition of having sealed honey above and around the brood area as if prepared for winter. Under such conditions the bees sometimes act as if they had finished the season's work, even though the honey flow is just beginning, and they often waste much valuable time loafing even during a good honey flow. Such colonies are usually among the first to prepare to swarm.

On the other hand, colonies that have their brood-chambers well filled with brood when the honey flow begins should enter and begin work in the supers promptly and should expand their work into additional supers, building combs in advance of their needs so that, even though they may be much stronger than the colonies which began their storing within the brood-chamber, they are much less inclined to swarm.

This highly desirable condition in all, or nearly all, of the colonies at just the right time is not easily attained, and too often only a small percentage of them happen to be just right in this respect when the honey flow begins; for it means that just at the beginning of the honey flow the colonies must have consumed practically all of the honey that had been stored within the brood-chamber for winter and spring, and at the same time must reach their maximum in brood-rearing.

Colonies that happen to be in this condition just at the right time are usually the ones which work in the supers with the greatest energy and give the least trouble from swarming.

To find the proper size for a brood-chamber that would hold just enough honey to carry the colony up to the beginning of the honey flow (at which time the honey should be practically all used up and the combs of the brood-chamber almost completely filled with brood) has been the dream of comb-honey producers for years. But the great variation in the way the bees come through the winter, the variation in the amount of honey stored from minor sources previous to the main honey flow, and in the time of the beginning of the honey flow have prevented the attainment of this goal.

Many comb-honey producers who have an equipment of 8-frame hives use two stories previous to the honey flow, to provide sufficient room for extra stores and brood-rearing, permitting the queen the free range of both stories. When the honey flow begins the hives are reduced to a single story by taking away most of the honey and leaving most of the brood. At the same time two comb-honey supers are usually given so that the total hive capacity is not reduced.

The combs that were removed (which may contain considerable honey and brood) are then given to other colonies, which need not be strong and which are not used for comb-honey production, where they are to be refilled with honey as the brood emerges, then put back upon the hives again after the comb-honey supers have been removed at the close of the season. The hive-bodies containing the combs that were removed may be piled six or seven high on top of weaker colonies. These "piles" soon become powerful colonies because of the large amount of emerging brood.

While this involves considerable labor, it puts the colonies in excellent condition to begin work immediately in the comb-honey supers. It is open to the objection that two sets of combs must be sorted, and it is sometimes necessary in this sorting to leave some of the combs which have a rim of sealed honey in the upper portion, these being combs from the upper hive-body. The plan is an excellent one, however, and may also be used with the 10-frame hive.

To bring about similar results with less labor some comb-honey producers who use the 10-frame hive have provided a shallow extracting super for each colony. These shallow extracting-supers contain the extra stores needed for safety during the spring, thus permitting the standard brood-chamber to be used almost entirely for brood. They are taken off at the beginning of the honey flow when the comb-honey supers are given. In this way the objectionable barrier of honey at the top of the hive is removed, and the comb-honey supers are placed down adjacent to the brood, which is a great advantage in stimulating the bees to expand their work into the supers and in reducing the tendency to swarm. This principle has been recommended by several beekeepers even when extracted honey is produced.

The shallow extracting-supers should be tiered up on weak colonies which are not being used for comb-honey production, for they should be refilled with honey as the small amount of brood which they usually contain emerges. After they have been filled with honey these food-chambers are ready to be given back to the colonies after the crop of comb honey has been removed from the hives.

The extra stores provided by either of these plans stimulate the bees to rear a large amount of brood during the spring, usually resulting in at least one standard brood-chamber's being well filled with brood at the beginning of the honey flow and colonies so strong that they begin work in the supers with a rush. (See Food-chamber.)

Thus by using a separate chamber for honey and a brood-chamber that a good queen can fill almost completely, the safety of the colonies, so far as stores are concerned, is insured without laborious and expensive feeding which is too often not done when most needed; and, at the same time, the objectionable rim of honey at the top of the hive can be lifted off and the comb-honey supers placed upon a brood-chamber almost full of brood and practically free from honey.

Where honey granulates readily the large surplus of stores may sometimes be objectionable, but where honey granulates readily comb-honey production is not advisable anyway. Colonies so provisioned usually build up so strong in the spring that most of the extra honey may be used up and the combs in the food-chamber are refilled with honey from early sources.

When and How to Put on Supers

The comb-honey supers should not be given until about the beginning of the main honey flow. If the colonies are in single-story hives at this time and have been equalized by exchanging combs of emerging brood taken from the strongest colonies and given to those less strong, the comb-honey supers may be given a few days before the beginning of the honey flow. If the colonies are in two-story hives, or if they are supplied with food-chambers, it is well to wait until the honey flow actually begins, for the hives must be reduced to single story when the comb-honey supers are given, and to reduce them before the honey flow begins might bring on swarming. In order to determine just when to put on the comb-honey supers it is necessary to know the source from which the main honey crop is gathered for any given locality. In the northeastern states where the major portion of the honey crop is gathered from white clover and alsike clover, the honey flow usually begins about ten days after the appearance of the first clover blossoms. This is usually from the first to the middle of June in the northern states. Where sweet clover is the chief source of nectar, and in the irrigated regions of the western states where sweet clover and alfalfa furnish the major portion of the honey, the honey flow usually begins a little later, when these plants come into bloom. In some portions of the South the main honey flow may come quite early in the season or there may be a succession of important honey flows with intervals of dearth between.

When an upper story of full-depth combs is used as a food-chamber, it is often necessary to sort the combs, placing most of the oldest brood in the brood-chamber to be left with the colony, and the combs containing honey and small patches of brood in the other chamber to be taken away. When a shallow extracting-super is used as a food-chamber, it frequently happens that it can be taken away without removing much of the brood. Such colonies are then in the best condition to start work immediately in comb-honey supers so far as the condition of the brood-chamber is concerned. This is especially true in case of the shallow extracting-super, for the rim of honey is removed when the food-chamber is taken away so that the sections can be placed close to the brood with no sealed honey between.

What to Do with the Food-chambers During the Honey Flow

Since it is necessary to take away the second story, or food-chamber, when the comb-honey supers are given for best results in comb-honey production, some provision must be made to take care of these upper stories during the honey flow. One way of doing this is to tier up these extra hive bodies, or shallow extracting supers, several stories high above colonies selected for this purpose. If any colonies are below normal strength they may be used for this purpose, since they would not give good results if used for producing

comb honey. The shallow extracting-super can be removed by smoking most of the bees down into the brood-chamber, then taking it off with but few bees in it. When full-depth hive-bodies are used for the second story the bees should be shaken from the combs that are to be taken away as they are sorted, the bees being shaken into their hive at the top or in front of the entrance. Several of these hive-bodies can then be tiered up on a weaker colony.

In either case the removed hive-bodies may contain considerable brood and honey. As this brood emerges, the colony becomes exceedingly strong, so that in a normal season the food-chambers thus tiered should be completely filled with honey during the main honey flow after the brood has emerged. A queen-excluder should be used to prevent the queen from going into the upper stories, and it is well to make an opening in the pile to permit the drones to escape from the hive, since there is almost sure to be some drone brood in the corners of some of the combs. It is sometimes necessary to give additional room to these colonies, in which event one or two comb-honey supers can be placed just above the brood-chamber and an escape put in place above the comb-honey supers, then the food-chambers put in place above the escape. After the bees have gone out of the food-chambers the latter can be given to recently made increase or otherwise stored until the close of the honey flow.

Another way of taking care of the food-chambers during the honey flow is to set them off without driving out the bees, but being sure the queen is in the brood-chamber. The food-chamber is then supplied with a bottom-board and cover and used to form a nucleus which is set close beside the hive or placed on top. In case there are not enough bottom-boards for all the food-chambers, some of them can be placed directly on the inner cover and an entrance provided in the rim of the inner cover or by pushing the food-chamber back on the hive until an entrance is formed, and laying a block in place to close the opening at the other end. In this way the only additional apparatus necessary is an inner cover. Within a few days a ripe queen-cell should be given to each of the nuclei thus formed. In this way young queens can be reared which will be useful later in swarm control or in replacing inferior queens. This method is especially useful when the food-chamber is nearly full of honey, when it is taken off. After the honey flow is over and the comb-honey supers have been removed, the old queen can be killed and the nucleus in the food-chamber united with the original colony. In this way the colonies are requeened and given ample stores for fall, winter, and spring in one operation.

In producing comb honey a critical time, as to swarms, comes when the hive is reduced to one story and comb-honey supers are given at the beginning of the main honey flow. The author has seen colonies occupying three or four stories, with bees touching the cover and the floor at the beginning of the honey flow, in which nearly all of the bees crowded down into the brood-chamber during a cool night after the hive was reduced to a single brood-chamber with two or three comb-honey supers added. Such a manipulation is the strongest kind of invitation to the colony to swarm.

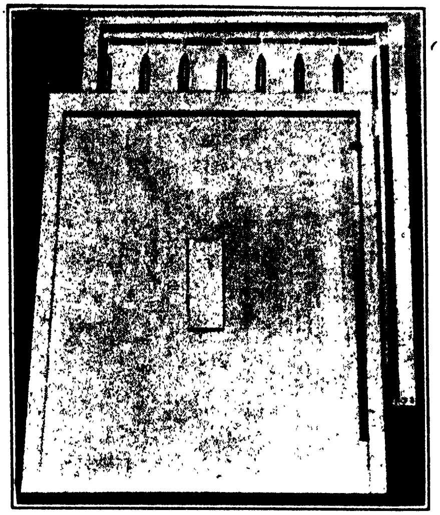
This is where the producer of extracted honey has great advantage, since he expands the hive by adding supers of empty combs instead of reducing it by taking away the upper story or food-chamber and giving comb-honey supers. Some have tried to relieve this condition

Passageway at side of super formed by 1/4" board with 3/8" cleats across ends. When the inner cover is in place the slot at the side is directly above the passageway behind the cleated board.

by lifting up the upper story and placing the first comb-honey super between the two hive-bodies, but when this is done it is necessary to take away the upper story a few days later, since otherwise the bees would discolor the combs in the comb-honey super.

This trouble can be avoided by placing the first comb-honey super between the two hive-bodies, with the upper story shut off from the comb-honey super, but with

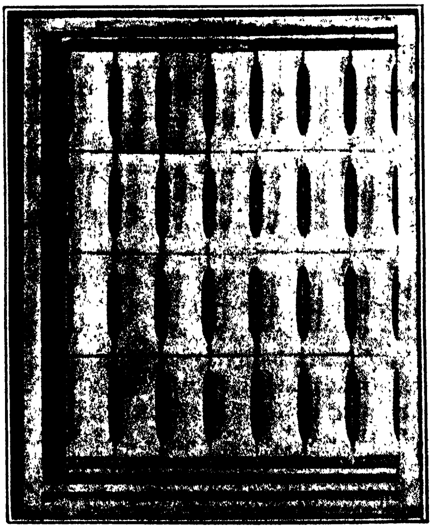
a passageway to the brood-chamber. In this way the hive is expanded at the beginning of the honey flow instead of contracted, as is actually the case so far as



Super with sections in place provided with passageway at side and inner cover with 3/8" slot cut through at one side.

the bees are concerned, when a two-story hive is reduced to one story and comb-honey supers given.

The runway from the upper story to the brood-chamber is provided by a 1/4" board the same width as the side of the super and slightly less in length than the inside length of the super. A 3/8" cleat as long as the board is wide, nailed across

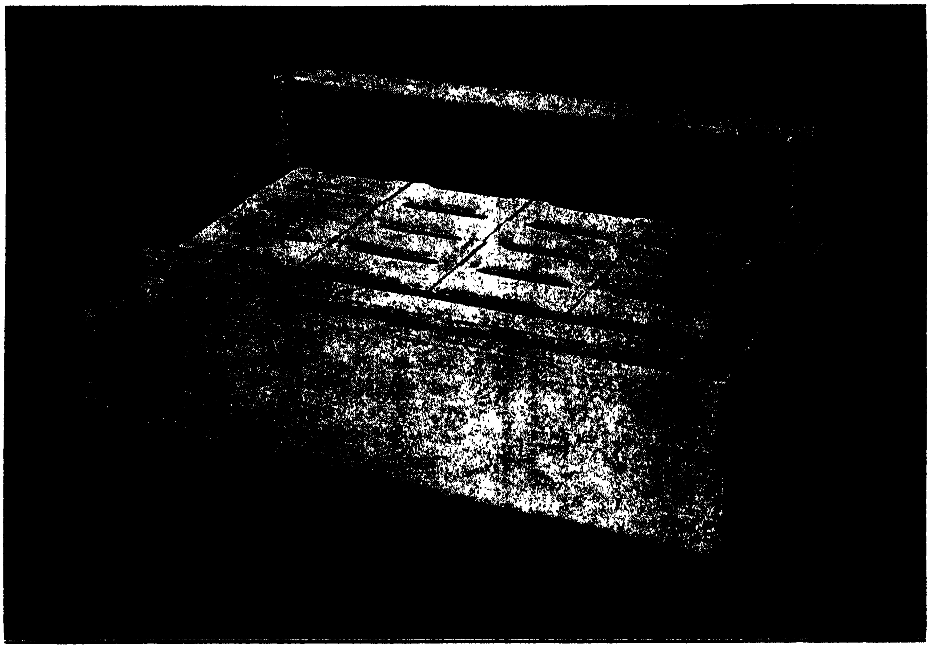


Super with passageway at end formed by nailing a cleated board on outer side of super end.

this board at each end, is shown in cut on page 190. The board is placed in the super with the cleats against one side. The top of this board is then flush with the upper edge of the super. When the super is put in place on the hive an inner cover having a 3/8-inch slot cut through the board just inside one side rail is placed on top in such a manner that the slot in the inner cover coincides with the opening between the board mentioned above and the side of the super. The upper story of the hive is then placed above this inner cover. The bees, in passing to and from the upper story, must pass through the runway at the side of the super since there is no other opening.

Super with passageway at end shoved forward on hive so that passageway opens into the brood-chamber.

Another way is to make a runway outside at the end. It is made by a 3/8" board cut exactly the size of the end of the super with a 3/8" cleat placed at each end. It is fastened to the end of the super by small nails driven through board and cleat into the super. The super is then pushed forward on the hive, as shown in the illustration, so that the board nailed on the back is flush with the back end of the brood-chamber. This brings the runway directly over the rabbet in the end of the brood-chamber. The super is then covered with an inner cover 3/4" longer than the regular inner cover and having a slot just inside the end rail. Such a cover can best be made by having the boards run crosswise. A simpler but not quite as satisfactory method is to cover the super with a piece of oil-cloth, being careful to leave the passageway at the end open, then place the upper



Super containing two extracting-frames, with wide end-bars, so that they take up the same amount of room as a section-holder.

story on top but pushed back far enough to make the inner edge of the upper story coincide with the inner edge of the board which forms the runway. This forms an opening at the front which must be closed by tacking on a piece of lath.

Most colonies arranged in this way start queen-cells in the upper story soon after the comb-honey supers are given, just as they do when brood is placed above an excluder. These are not swarming cells but supersedure cells. They should be destroyed ten days after the two chambers were separated by placing the comb-honey supers between, unless wanted for requeening or increase. Later, after most of the brood has emerged in this upper story, it can be taken off for increase or tiered up on another hive.

Bait Sections

A *bait section* is one which has been partly filled with honey, which honey is afterward extracted or emptied out by the bees, generally in the fall. It is thus a section containing drawn comb, but having no honey in it—to all intents and purposes an extracting-comb on a small scale. Bait sections thus prepared are kept over winter to be used at the beginning of the next honey harvest.

If a single bait section is put in the middle of the first super that is given to a colony, some claim that the bees will begin work in it as promptly as they will begin work in an extracting comb. Others use more than a single bait in a super, but there may be no great advantage in this, and the number of baits should be limited as much as possible, for when a section is thus filled the second time it is not so beautiful as one filled the first time. A bait section is not needed in any super after the first.

One serious objection to bait sections is that they are never as nice as those built from foundation, and should always be sold near home as soon as possible after they are taken off the hive. This objection can be overcome to a large extent by shaving down the comb with an uncapping knife so that the cells are not more than ¼" deep before giving to the bees. Instead of bait sections some use comb-honey supers arranged to take a shallow extracting comb on each side as here illustrated.

What to Do When the Bees Refuse to Enter the Sections

There have already been given some general suggestions that should enable the producer to get the bees up into the supers. One is to give the bees a super of empty extracting-combs. After they once start in them, place a super of sections between it and the brood-chamber. Another is to use the extracting-combs as well as sections in the same super; another is to use bait sections; and still another is to run the colonies two-story during the breeding-season, then remove the upper story and put on a super of sections as explained elsewhere. When all of these devices fail, it may indicate that the weather is too cold, even though there is plenty of bloom, or that the colony is not strong enough to go into the supers. If the weather is cool or chilly or the colony not strong enough, no amount of "baiting" will get the bees above. The weather conditions must be right, and honey must be coming in at a fairly good rate, even if the colony is strong enough, before the bees will go above. But when they are once started they will keep it up as long as anything is coming in.

If some colonies are storing in the supers and others are not, this indicates that the weather conditions must be right; and the presumption is that the laggards are not strong enough to go above. If they have plenty of bees, it is sometimes advisable to give a super from some other hive in which the bees have already started building comb and storing honey. In other cases, either baits or empty combs may be used on the sides. It is important that the bees in hot weather shall not be driven out of the supers by the direct rays of the sun. In some localities at least, shade must be provided, so that the bees will be protected during the middle hours of the day. (See Apiary, and especially Shadeboards.)

If the bees of a strong colony hang out in front of the entrance, while the bees of other colonies are storing honey, perhaps enlarging the entrance or putting the hive on four blocks, may serve to get the bees inside at work in the supers.

It sometimes happens that the broodnest is not filled with brood and honey. Until it is, there will not be much work done in the supers unless the colony is very strong or honey coming in rapidly.

Occasionally a colony will be found which stubbornly refuses to work well in comb-honey supers even after the brood-chamber is crowded with brood, pollen, and honey, and when other conditions are apparently favorable for work in the supers. Such colonies can usually be induced to go to work in the sections by taking away their combs of brood, thus making an artificial swarm. (See Artificial Swarming.) But often a better way is to give such colonies supers of empty combs to fill instead of comb-honey supers. These supers of honey can then be used as food-chambers. (See Food-chamber.)

Tiering Up

After work is begun in the first super, if no other supers are given until the combs are built out it should be noted that the space within the super that can be occupied by bees is being reduced as the combs are drawn out, until finally there is only about one-fourth of an inch left between the comb and the separator, so that most of the bees are crowded out and must go back into the brood-chamber. This is almost sure to cause the colony to work less vigorously. The same thing happens if the bees are driven from the super because it is too hot or because the hive is not well ventilated. If the colony

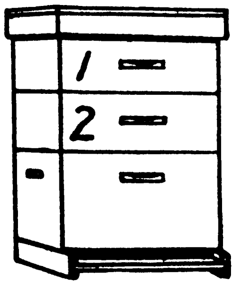


Fig. 1.—Second super placed below the first.

is strong enough to draw out the foundation uniformly in all of the sections, and the honey flow is promising, a second super should be given, even though but little honey is stored in the first one.

In order to induce additional comb-builders to go up into the supers, this second super may be placed below the first one. If conditions are favorable, the foundation in the second super will be drawn out within a few days and these shallow cells can be used for the evaporation of the incoming nectar. The bees apparently enjoy spreading out the raw nec-

tar, a little in each cell, thus hastening its ripening by increasing the surface of the nectar exposed to the air. Before much honey has been stored in the second super it may in turn be raised up and a third super given. This operation may be repeated as often as necessary to keep the bees busy drawing out foundation and to attract more and more of the younger bees from the brood-chamber into the supers. In order to hasten the completion of the first super that was given, it may be placed immediately above the super in which the bees are drawing out foundation, while the other supers are arranged above it in the order that they were put on the hive, the one in which the least work is done being placed on top.

If it were possible to foretell the number of supers that each colony would finish during the honey flow, it would be well to induce the bees to draw out the foundation and begin comb-building in that many supers as early in the honey flow as possible, then give an extra one to be placed on top as soon as the foundation is completely drawn, the purpose of this extra super being to contain the overflow of nectar during the process of ripening. This extra super, having served as an evaporating chamber this season, can then be taken off before the combs and sections become soiled with propolis and be given as the first super next year.

Caution

Colonies that are not strong enough to send a large force of comb-builders into the first supers should not have their super room expanded so rapidly. A good rule to follow is to place the new super under those in which work has been started, provided the colony is strong enough, and the honey flow is good enough to cause the bees to draw out the foundation uniformly throughout the super. If they draw out only those in the middle of the super, the second super should be placed on top at first, and no super should be raised up and another put under it until the foundation has been completely drawn in all of the sections. If the honey flow is slow or if the nectar is thicker when first gathered, the work of drawing out the foundation, comb-building, the ripening of nectar, and sealing the honey may all be done in a single super. In this case the newly added super should be placed on top.

The thing to keep in mind when adding supers is to avoid, on the one hand, too many unfinished sections by giving additional room too fast; and to avoid, on the other hand, the lack of stimulation which comes from newly added room for new work and an abundance of comb surface for ripening nectar. The surplus compartment, whether made up of one super or half a dozen supers, should have some fresh foundation being drawn until near

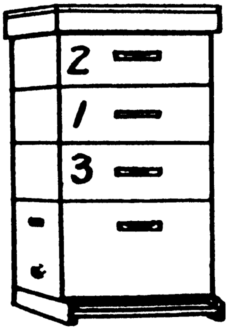


Fig. 2.—Third super placed below and first just above it.

the close of the honey flow. Rapid expansion of super work should take place during the early part of the honey flow, while during the latter part of the honey flow the super work should be concentrated.

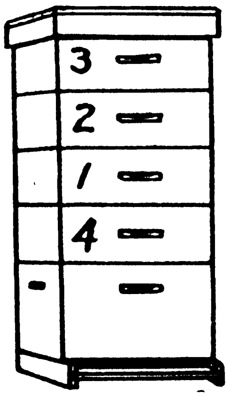


Fig. 3.—First super left in same position until finished.

During hot weather added ventilation may be given by pushing the first super forward on the brood-chamber about an inch. This will form an opening at the back of the hive just above the ends of the top-bars of the brood-frames. Such openings should not be made between the supers, since the bees may fail to finish the section nearest the openings.

The beekeeper who by skillful supering is able to entice most of the rapidly oncoming younger bees into the supers early in their lives, and who keeps his colonies comfortable at all times, thereby increases his crop. With most of the younger bees in the supers and most of the older bees in the fields during the heat of the day, the colonies work with the greatest energy and are much less inclined to swarm than when the supering is not properly managed.

As Close of Honey Season Approaches

The first step in anticipation of the closing of the season is the giving of additional super room more sparingly. After the beekeeper has been doing his utmost to induce the bees to occupy and begin work in more and more supers during the fore part of the honey flow, the tendency is to go ahead giving additional room at the same pace too long. At a certain stage in the honey flow the emphasis should change from the expansion of the surplus room to a concentration of the super work to the smallest number of supers possible and still give the bees sufficient room.

It is sometimes a good thing if the beekeeper runs out of supers during the latter part of the honey flow, for it is surprising how much can be done in the way of furnishing enough room without giving additional supers by shifting supers from one colony to another, thus giving a little more room to colonies that are beginning to be crowded and reducing the super room in those having more than they need. In fact, there comes a time during the latter part of the honey flow when it is better to have the colonies crowded a little for super room, but the difficulty is to know when this time has arrived. The bees will usually stand a degree of crowding at this time which earlier in the season would have caused them to swarm or to loaf badly. Any new supers that are given at this time should usually be placed on top of those already on the hive.

The second step in preparation for the close of the season is that of reducing the number of supers on each hive to one or two as soon as possible, concentrating the unfinished sections in these supers. Sometimes the bees are slow about sealing the honey, when it may be necessary to tier up the supers, four, five, or even six high, before any of them are ready to be taken off. At other times they seal the honey more promptly, so it is not necessary to tier up more than three supers high. Usually the bees seal honey more promptly toward the latter part of the honey flow.

As a rule it is not advisable to leave the supers on until all of the sections are finished; for the longer the honey is left on the hives, the more travel-stained it will become and the more it will be soiled with propolis. This is especially true late in the honey flow. When most of the sections are finished the super should be taken off and the unfinished sections sorted out to give back to the bees for completion. It is not safe to assume that a super is ready to be taken off by looking in at the top only. It is better to look in at the bottom also, for sometimes the sections of honey are sealed near the top and not sealed near the bottom.

Let us suppose that, as the close of the season approaches, a colony has five supers, four of which are nearly filled, and work has just been started in the fifth, there being enough unfinished sections scattered through the four supers to fill one super. If these four supers are now taken off, the unfinished sections sorted out and assembled in one super which is put back on the hive, the work of finishing these sections will be carried on more rapidly, especially if the super of nearly finished sections is placed next to the brood-chamber, with the one in which but little work has been done on top.

Of course these four supers would probably not all be ready to be taken off at once, but by going over all the supers every four or five days at this time, taking off and sorting those nearest completion, the supers can soon be reduced to a single nearly finished one for each colony, with an empty or nearly empty one to act as a safety valve if more room is needed. If there are not enough supers, in which but little work has been done, to go around, an empty super should be given, provided there is still enough nectar coming in so that the bees will draw out the foundation, for the nearly finished super is usually finished more promptly if the bees are permitted to build comb in another super at the same time.

If the beekeeper has guessed well, the lower one of these two supers should be nearly finished just before the honey flow

entirely ceases and the upper one should have but little unsealed honey stored in it, yet the foundation should be well drawn out and some of the combs at least partly built. This super, if taken off promptly and the bees permitted to clean out the little honey it contains, is just right for the first super next year. It is not possible always to guess so well as this. While some colonies may come out just right, others will store considerable honey in the top super, and still others will not complete the lower one, so a further but final sorting of sections becomes necessary.

During the time this last super is being finished it is well to watch closely for colonies that are good finishers, as usually several colonies will be found in an apiary of sixty to eighty which do much better work at finishing than the others. These should be marked to be used in the final work of finishing.

The third step toward closing the season is that of removing all of the supers, doing this, if possible, before the honey flow entirely ceases and before the bees begin to varnish the cappings of the honey and the section boxes with propolis. The sections in the nearly finished supers should again be sorted and the unfinished ones given back to those colonies which were marked as the best finishers. This time, in assembling these unfinished sections in the supers, those nearest completion should be placed in the middle, putting sections only partly filled in the outside rows. These sections for the outside rows may be taken from those supers which were on top acting as safety valves. As these supers are now arranged, the finishing is to be done in the middle of the super where it will be done more promptly, while the comb-building, if any, is done on the two outside rows.

What to Do With Unfinished Sections

The supers in which but little work has been done can now be piled up crisscross near the apiary, and the bees invited to help themselves, provided there are enough such supers so that the bees will not crowd each other so much that they will tear down the comb. This, of course, should not be done if there is any foulbrood among the colonies or if the apiary is too close to a neighboring residence.

The last supers which were given to the finishing colonies should not be left too long, but should be removed as soon as most of the sections are finished. Usually it does not pay to return the unfinished sections from this last lot of supers for completion. Some of these may be sold as culls, or cut out and sold as chunk honey. Many comb-honey producers extract the honey from these unfinished sections and save the combs for bait sections.

The important thing in taking care of unfinished sections to be used again the next year is to take them off before the wood is soiled with propolis and the foundation gnawed at the edges and also varnished over with propolis.

If the honey flow fails suddenly, affording no opportunity to return unfinished sections to the bees for completion, they may be completed by feeding back extracted honey. (See Feeding Back.) In this case, the unfinished sections may be sorted into different grades and the lightest ones extracted to secure the honey to feed back in finishing the heaviest ones.

Feeding back extracted honey to secure the completion of unfinished sections was formerly practiced to a considerable extent by comb-honey producers, but has been discontinued by most of them. Comb honey finished by feeding back is usually inferior in appearance, tends to granulate early in the winter, and much more honey must be fed than is finally stored in the sections, a large amount being consumed by the bees during the process. Successful feeding back depends so much upon selecting colonies that are in just the right condition for this work and upon weather conditions at the time the feeding is done, that few will care to attempt it, preferring to sell the unfinished honey as culls and extracting that which can not be sold in this way. (See general heading, Feeding Back.)

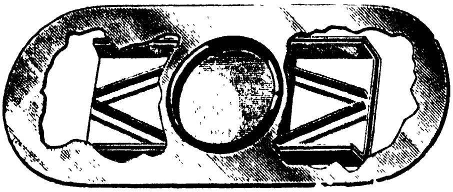
How to Take Off Comb Honey

There are two methods of removing bees from the filled supers. One is by the use of a bee-escape, a device that will allow the bees to pass through a self-closing exit or gate, and the other is by the use of carbolic acid fumes that are very repellant to bees. The one prevents the bees from coming back into the super by the way they went out, and the other forces the bees out of the super through the means of an offensive gas or vapor like that from carbolic acid. Both are effective and reliable. The first method will be described first as it has been in use much longer.

Method of inserting the escape-board.

Various forms of bee escapes have been devised. The simplest is a wire cloth cone with a small opening at the top just large enough to let a bee through. Bees will readily go through this but will not be likely to return because they will seek to enter at the large part or bottom of the cone. Several forms of self-closing gates have been devised. The teeth or prongs raise as the bee passes and then by gravity drop down, as in the case of some mouse and rat traps. Mr. R. Porter some 20 years ago conceived the plan of a pair of delicate springs between the points of which the bees could push through easily. The points would then close, making an opening so small that they could not pass. As the exit would in a few cases clog, the escapes were provided with double springs or exits, as shown. The Porter escape is so far superior to the other forms of escape that none others are used.

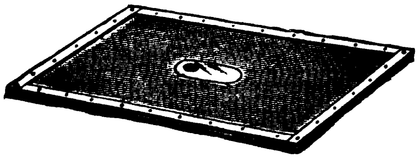
The escape is mounted in a board, cleated at the ends and sides in such a way as



Porter double-exit bee-escape.

to provide a bee-space on one side, so that it can be placed between the supers and the brood-nest beneath. But care should be taken that it be placed right side up—that is, the side up as shown in the illustration next column.

One method of putting on one of these escape-boards is as follows: With a hive-tool, screw-driver, putty-knife, or pry, loosen the super so that propolis connections will be broken. With one hand tilt up the super at one end enough to make a gap, and with the other hand take the smoker and blow in two or three whiffs of smoke to drive the bees back. Lift the



Bee-escape in place in escape-board.

end of the super up a little further so that it will stand at an angle of nearly 45 degrees. With the free hand set down the smoker and pick up the escape-board, which should be leaning conveniently against the leg. Slide this on top of the hive as far as it will go, bee-space side up. Let the super down gently on the escape-board, and, last of all, bring the escape board and super into alignment with the hive. This method eliminates hard lifting, saves time, prevents angering the bees, and avoids killing them. See illustrations above.

The best time to put on Porter escapes is always in the morning. The field bees in the supers will leave to go to the field during the day, and, of course, can not get back. If 30 or 40 of the escapes are put on, the next morning about nine o'clock there will be 30 or 40 supers ready to come off, with but few bees in them. If there are three or four bees left, or a dozen, they will usually take wing as soon as the super is uncovered.

One difficulty with any form of bee-escape is the element of time. Where there are outyards, and especially where there

are a series of them, it is necessary to make two trips to each yard, one in the morning to put on the escapes and one to take off the supers and the escapes the next day. This can be overcome by the use of carbolic acid.

The Carbolic Acid Plan of Removing Bees from Supers

This is a new old way of freeing bees from supers, but was not developed to a workable success until 1932 when Charles Mraz, Middlebury, Vermont, brought out his plan. (See Gleanings in Bee Culture, page 412 for 1932, and again in the same journal on page 350 and 601 for 1933.)

The use of carbolic acid for driving bees from supers has been known for many years. The old plan involved only a weak solution of acid and water. An oblong piece of cloth a little larger than the top of the hive used, was dipped in the solution, wrung out and then placed on the super. In fifteen or twenty minutes the bees would go down out of the super into the body of the hive. The process was slow and sometimes left an odor to the removed honey. Mr. Mraz has overcome both of these difficulties. He uses a much stronger solution and a pure chemical with less of the offensive odor. His plan in brief is as follows:

How to Prepare and Use the Solution

Go to the drugstore and get a blue bottle of pure carbolic acid crystals and dilute this with 25 per cent of water. Crude

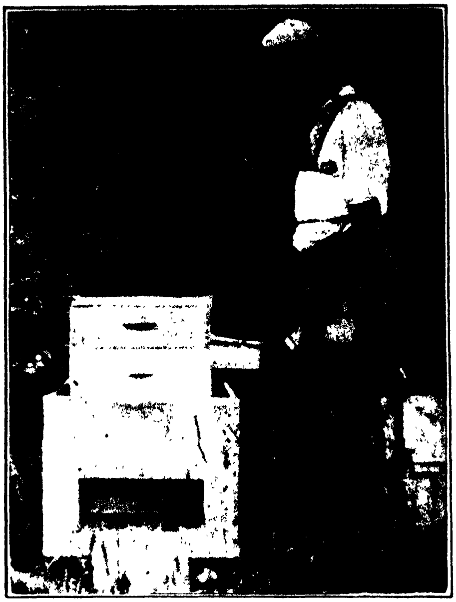
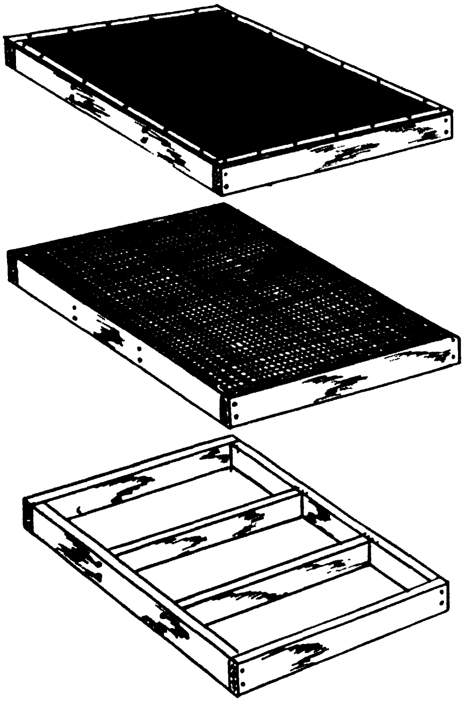


Fig. 1.—A carbolated screen is placed on top of the finished super which in turn is on top of the unfinished supers.



This shows the construction of the screen, the bare frame at the bottom, frame covered with several thicknesses of cheesecloth in the middle, and the finished frame covered with a sheet of black canvas at the top.

carbolic acid should never be used as it will taint the honey. If you can not get from your druggist the pure article in crystal form go elsewhere because it is necessary that you have only the best.

While a 50 per cent solution will do good and quick work on hot days the 25 per cent water dilution is better for ordinary conditions; but it should be noted that either solution is corrosive to the fingers. It would be impossible to wring out a cloth dipped in either strength of liquid without burning the fingers. To overcome this difficulty, Mr. Mraz devised a screen that is tacked on a wooden frame with cross pieces, as shown in the drawing.

The dimensions should, of course, be the same as the top of the hive or super and about an inch and a half deep. On this framework should be tacked several thicknesses of cheesecloth and over all some black material like oilcloth to draw the sun's rays, for it should be noted that

the fumes of the acid are much more active on a hot day or under a hot sun than on a cool day when there is no sun.

The solution, preferably a 25 per cent dilution, should be put in a bottle with a

Fig. 2.—Sometimes a little smoke is blown under the screen to cause the bees to hasten from the super.

sprinkler nozzle, such as the housewife uses for sprinkling her clothes. With the bottle of solution well shaken the underside of the screen should be sprinkled just enough to make the cheesecloth wet but not dripping. Six or eight of these screens should be provided.

We are now ready to take off the supers free or nearly free of bees, all on the same trip and almost in the time it takes to tell it. It should clearly be understood that the liquid should be well shaken and that it is the fumes of the acid that drives the bees down. Mr. Mraz tells us how he proceeds:

Beginning with the first hive in the yard, the supers are taken off and the necessary work is done in the brood-chamber. The supers are then put back on the hives, the unfinished ones first and the finished ones on top. A carbolated screen is then placed on top of the finished super as shown in Fig. 1. The next four or five hives are treated in like manner until all screens are in use. When the next hive is ready for a screen, the super on the first hive is taken off, together with the screen as in Fig. 3. On a warm, sunny day, the super will be clean of bees excepting perhaps a few on the bottom that are brushed off. The super is carried away and the screen placed on the next super ready for it. The process is continued until all hives are taken care of.

If the weather is cool or cloudy, a little smoke blown under the screen (Fig. 2) as it is flapped up and down a few minutes before removing the super or at the time the screen is put on, will put action into any lagging bees. If the super still contains bees after it is lifted off the hive, stand it on end, blowing smoke through from the top with one hand and brushing bees off the bottom with the other as in Fig. 4. After a carbolic screen is used on a super, the bees are more easily driven out by smoke than when no screen is used.

When there is no robbing, the supers are loaded into the truck as they are taken off. After a little experience they can be taken off the hives as fast as they can be carried away. One day last summer a helper and I arrived at a yard at 9 o'clock; about 11:30 we were on our way home with nearly 100 full supers of honey on the truck, and, by the time we got home, not more than 50 bees were left in the whole load.

When escapes were used, I disliked most of all stripping off honey after the honey flow. I'm sure most beekeepers who have trouble from robbing feel the same way about the job. The bees always manage to rob out a few supers over escapes and when taking off the honey and loading it on the truck, it's a battle with robbers from start to finish. Last year I stripped off all honey from the hives after the honey flow stopped and had very little trouble from robbing.

Storing Comb Honey

It was formerly advised that comb honey be stored in a well-ventilated room and the supers piled in such a manner that the air could circulate freely among the sections, the theory being that this

Fig. 3.—When the bees have left the super, it, together with the screen, is quickly placed on end and any bees left on the bottom are brushed off.

arrangement would permit a further ripening of the honey after being removed from the hives. The plan is open to the serious objection that honey so exposed may absorb moisture if subjected to any great variation in temperature, for warm air which contains considerable moisture, coming in contact with cold honey, if

Fig. 4.—If any bees are left in the super, a few puffs of smoke at the top and prompt use of the brush at the bottom will completely clear the super of the remainder.

chilled sufficiently, will give up some of its moisture, causing condensation on the surface of the honey. Honey that is well ripened is usually safer if the supers are piled in tight piles, the piles being closed at top and bottom. Its aroma will be better retained also.

Scraping Sections

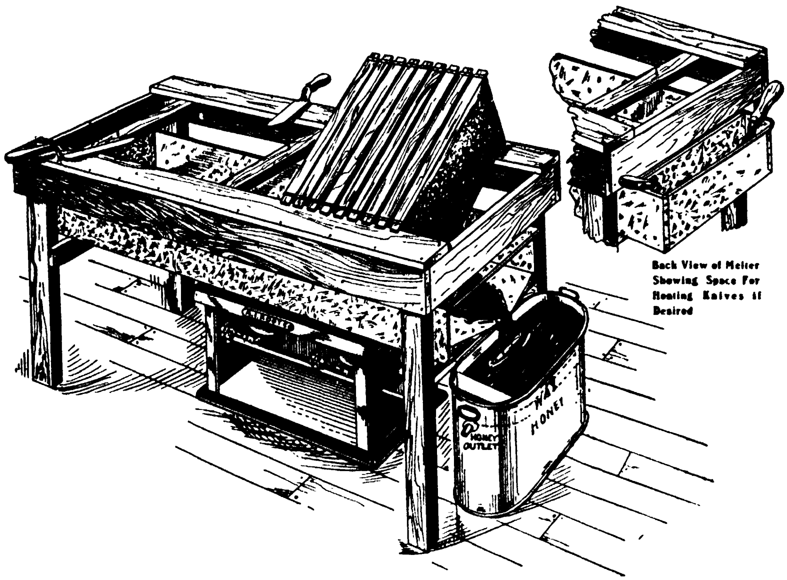
In order to make sections present a clean and marketable appearance all the propolis should be scraped off. Some and perhaps most beekeepers prefer for this purpose a common case knife, and others a sharp jackknife. Sometimes the edge of a scraping-knife is ground square, and the scraping is done with a corner of the knife. But the general practice seems to favor the ordinary edge. Others prefer to use No. 2 sandpaper. A sheet of it is pasted flat on the table, and the section, edges down, is rubbed back and forth on the rough surface. If the day is not too warm, nor the propolis soft, the sandpaper will do faster work than a knife. But the edges of the section are a little roughened, and more or less fine dust at times gets on the surface of the comb. Sometimes a dealer on receiving such honey objects to this dust, thinking it to be the excrement of the moth worm. The objection is also made that the sandpaper fills up with the bee-glue, and that is true. But sandpaper is cheap, and when one sheet is filled, another can be used, and so on.

When one has a large amount of comb honey the work can be done with sandpaper more expeditiously by fastening it on a revolving cylinder or on the flat surface of a revolving disk operated by foot power or a small motor. Where one has a gasoline engine for a large power-driven honey- extractor, he can use that as a motive power. The author's experience is, however, that a power-driven cylinder or disk, on account of the high speed, does not scratch the sections nor leave the surfaces of the comb covered with dust.

Section-scraping Table

A small table of a height that will just slip over the knees is much better than one of ordinary height. To keep the scrapings from flying all over the floor it is advisable to tack thin boards six or eight inches wide over the two sides and at the back, leaving the front open. Newspapers laid over the table and folded against the sides and back, will catch the scrapings of bee glue for the day, when paper and all can be burned.

A block 2 inches thick, more or less, and 4 inches square, the size not being important, lies on the table, or on a board on the lap. When the section is placed upon this block, projecting over one side, it allows free play for the knife. If the super is of such character that the sections may be taken out *en masse*, the work may be greatly shortened by cleaning all the tops at one operation, and the bottoms in the same way. No matter what the super, one may shorten the work in this way: Make a rim, or box without top or bottom, whose depth is an inch less than the height of the sections to be cleaned, and an inch or so wider and longer than the superful of sections. Have two boards as large as, or a little larger than, the rim mentioned. Lay a board on the table, set the rim on the board, and then fill the rim with sec-



Capping-melter and wax-separator here recommended for liquefying candied honey. Although designed for melting cappings as explained under Extracted Honey, it may be used as a liquefier if a screen is put across the open end to prevent the solid portions from sliding out. As soon as the honey is melted, it runs out, away from the heat.

tions. Put into one end a thin board as a follower and wedge it up. Do the same at one side. Now, with a cabinetmaker's scraper or some other tool scrape the propolis off the entire surface. Follow this up with No. 2 sandpaper. Now lay the other board on top of the sections. Turn the whole thing upside down. Take the top board off the sections. Loosen the wedges as much as necessary to let the rim drop down on the board, and then wedge tight again. Scrape and sandpaper as before. The sections may now be taken out and finished on the little blocks as before mentioned. It is a convenience to have a large table and a number of boards. Each board may be slid along on the table out of the way, or it may be piled up on another boardful of sections.

Both scraping and sandpapering will work better when it is so cool that the glue is brittle. Indeed, sandpaper will not work on soft glue.

Granulated Comb Honey; What to Do With It

If dealers are not suspicious regarding comb honey and have not had their heads filled with stories of artificial comb honey, they can probably sell granulated comb honey at very near the same price as that which is still in the liquid form; for granulated honey in the comb is fine for table use. Some explanation should be made, however, to the effect that the honey going "back to sugar" does not indicate at all that the bees were fed sugar syrup, and that nearly all kinds of pure honey will granulate in time. (See Granulated Honey.)

The Jews, in their religious festivals at certain seasons of the year, use considerable granulated comb honey. The honey and wax make up the right combination for their purpose, and very often granulated comb honey can be sold to the Jews at fair prices.

If it is impossible to sell granulated comb honey at a reasonable figure, it may be melted in a capping-melter, and the liquid honey and wax saved and sold separately. If there is any great amount of honey to melt in this way a large capping-melter should be used, for it is important to have a good-sized heating surface so that the melted honey and wax may be separated as soon as possible. If a small melter is used and overloaded, much of the honey is likely to be confined in close contact with the heated surface for some time; and this, in connection with the wax, imparts to it a flavor that, while not disagreeable, distinguishes it from honey not so treated.

On this account the outlet of the melter must not be allowed to dam up so as to confine the honey.

A framework, on which a wide board may be secured directly over the melter, should be made to fit the top of the melter. Use a sharp butcher-knife or steam uncapping-knife to cut the comb out of the section, then strike the notched or dovetailed corner of the section, causing it to fly open, allowing three sides of the section to lie flat on the board. Beginning at the right-hand end, move the edge of the knife with a scraping motion toward the left, holding the section in the left hand by the fourth side, which should be at right angles to the other three sides lying flat on the board. Then, using the other edge of the knife, begin at the top of the fourth side and cut down to the board, thus removing quickly all the wax adhering to the wood. With a little practice the honey may be cut out of the sections very rapidly — perhaps faster than the melter can handle it; but in the intervals the heaps of scraped sections may be removed, and new cases of honey set in readiness on the bench.

The mixture of melted honey and wax, as it comes from the melter, should pass directly into a separator made on the principle of the Aikin separator. The cut on next page shows the melter, separator, etc. At the end of the day, or when the work is finished, the honey should be drawn off as close as possible to wax, so that the smallest amount will be left to cool with it. The reason for this is that any honey is given a slightly waxy flavor if allowed to cool under wax. As soon as the honey is drawn off, and while it is still warm, it should be strained through a cheese-cloth, so that it will be ready for market. (See Granulated Honey.)

How to Keep Comb Honey and Prevent it From Granulating

It is sometimes desirable to keep comb honey for a better market, or hold it for a reserve supply the year round. To keep it with unimpaired flavor it must not be subjected to dampness. If water condenses on the surface of the comb the honey is soon diluted, and then it sours. On this account the honey should never be put into a cellar or other damp room. It should be kept in a warm dry room; and that there may be a free circulation of air, without admitting bees or flies, the windows should be covered with painted wire cloth. The publishers are accustomed to keep comb honey the year round, and rarely does it deteriorate in the least.

Comb honey should under no circumstances be stored where it is likely to freeze, as freezing contracts the wax so as to break the combs and let the honey run. It should be kept as nearly as possible between 70 and 90 degrees F., not be exposed to rapid changes in temperature at any time; and it should never go below 70, *if it is possible to avoid it.* According to Phillips, Dyce, and Wilson, granulation of most honeys starts most easily at between 57 and 60 degrees F. Below 50 and above 70 degrees F. it is retarded. At about 80 and 85 comb honey keeps best. (See Granulation and Honey Spoilage.)

Perhaps one in a small way might be able to keep a room hot by the use of a hard-coal stove, from which a regular heat will be given off; but this would be expensive, and make the honey cost too much. In some instances one might store the honey in the cellar near the furnace. This would give a uniform heat night and day. After the furnace fire goes out for the summer the honey should be moved to where it is dry.

The Temperature to Arrest Granulation in Comb Honey After it Begins

The publishers of this work conducted some experiments to see how hot they could keep the room and not have the combs melt down. They found that the temperature must not go higher than 103° F. While this may seem excessively high, yet, if the honey begins to granulate the only way to arrest the process is to bring the temperature up to 103°, and *maintain it there.* But there is the difficulty. They accomplished it by putting steam coils in the room with sufficient radiation so that the temperature could be held between 101° and 103°. If it goes above the high point, an automatic regulator, something on the plan of an incubator-valve, allows the heat to escape. As the temperature drops, this valve closes.

They kept some 2000 pounds of honey in this room for two months. Some of the honey had already begun to granulate, and it was their hope that they could not only arrest the granulation but bring the honey back to a liquid condition. In this last they were disappointed, but they suc-

ceeded admirably in stopping the process that would have soon ruined this whole lot of honey.

They are not sure but a temperature of 100° F. might do as well, and possibly such a degree would be safer for the average person to use, because, if the thermometer shows higher than 103°, there is great danger that the combs will be overheated, sag, and set the honey to leaking. It should be stated that a temperature of 100° F., while it will stop granulation, will cause honey to become very thick and waxy. This is objectionable to some of the trade.

COMBS.—Under Honeycomb, further on, a comb as a container to hold the honey gathered by the bees, its general structure, and how the bees build it without artificial aid are considered. Under Comb Foundation is shown how combs are built by the use of artificial aids; under Manipulation of Colonies, how combs or frames are handled. Under this head will be discussed the economic and comparative value of good and poor combs when used in brood-frames.

Next to poorly made hives that require a hatchet or cold chisel to open, or poorly made frames that one can't put into or take out of a hive, are poor combs, especially drone combs. The bad equipment means a big waste of time, infuriated colonies, a painful lot of stings, and a whole apiary in an uproar.

The bee inspector who is obliged to see every inch of comb surface is sometimes made mad enough to burn the whole outfit, disease or no disease; but he must grin and bear it because it is a part of his job. If he finds disease on top of skinned knuckles and his stings, he is more apt to burn, believing that he is doing the owner of the layout a real favor. There might be a little ugly feeling in that he was getting even with the owner.

The economic waste of poor combs is more often passed over in silence both by the inspector and the beekeeper unless the combs are so crooked or uneven that they crush bees in the attempt to remove

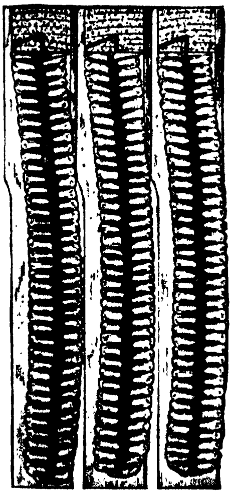


Fig. I.

I. If comb foundation is not reinforced with **HORIZONTAL WIRES** threaded through the end-bars, heavy clusters of bees are likely to get on one side and "warp" the foundation out of the frame, resulting in a bad situation later on. This is almost sure to happen whether the hives are level or not. See above.

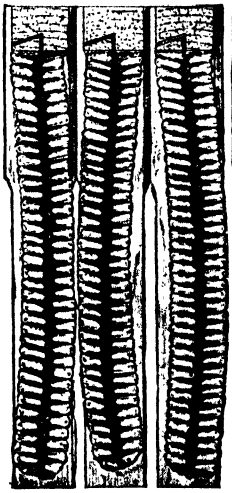


Fig. II.

II. But later on, if the combs are interchanged, as they must be, or turned around, there is trouble. The bee space is either reduced to nothing or greatly increased. Either condition makes trouble. The bees do not leave the combs in this condition very long. They attempt to straighten the surfaces, but the centers they can not change. See above.

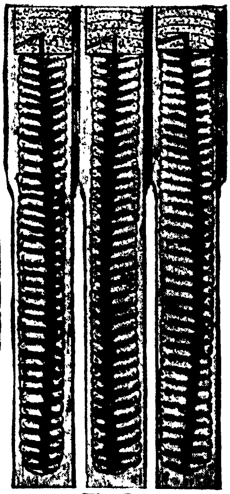


Fig. III.

III. And finally the bees may straighten the surface of the comb, but the center of the mid-rib remains warped forever, causing a bad lack of uniformity in the depth of the cells. Bees can not rear worker brood in shallow cells. They are likely to reconstruct very deep cells into drone cells, and the brood nest is thus "patchy." See above.

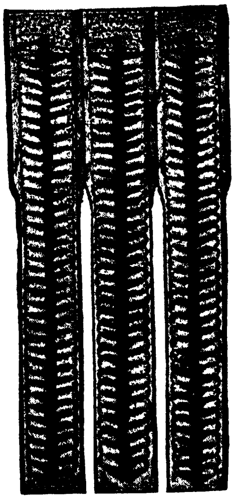
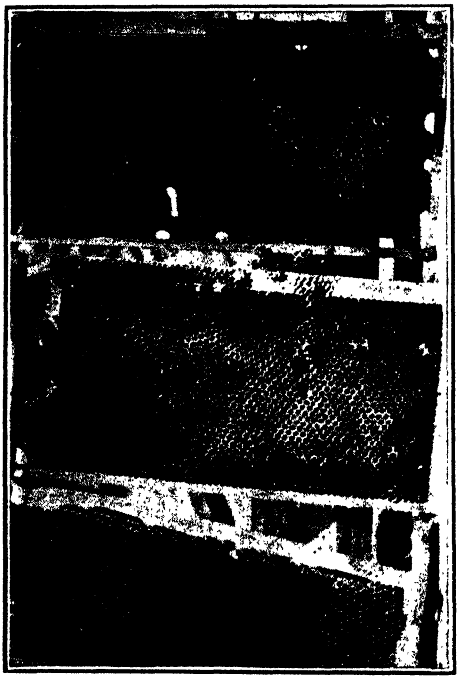


Fig. IV.

IV. The above combs are built on reinforced non-sagging foundation with four **HORIZONTAL WIRES**, threaded through the end-bars. They are straight combs —straight on the surfaces, and straight in the centers—with cells of uniform depth throughout. The queen can thus arrange a compact brood nest; swarming is reduced. See above.

them. Then look out, and ouch! The matter is made worse when the position of such combs must be changed. The crooked combs can be removed from the holes where they were built but can not be put into other places with their fat and lean sides to smash bees. This is shown in the cross section of combs shown on previons page with the legend beneath that tells the story.

Combs built on reinforced foundation on four horizontal wires will be all worker and as even as a board. There is no valid excuse except shiftlessness or laziness for



Combs that have been sorted out to be melted. All such combs should be replaced with good ones or frames of foundation.

having anything else. Foundation costs money but it saves it many times over in brood, stings, lost time, and in actual honey or money earned. If the crooked comb has much drone comb in it, thousands of useless drones are reared. Even if the comb is as straight as a board but all drone, the queen is quite liable to hunt it out and lay drone eggs in every cell.

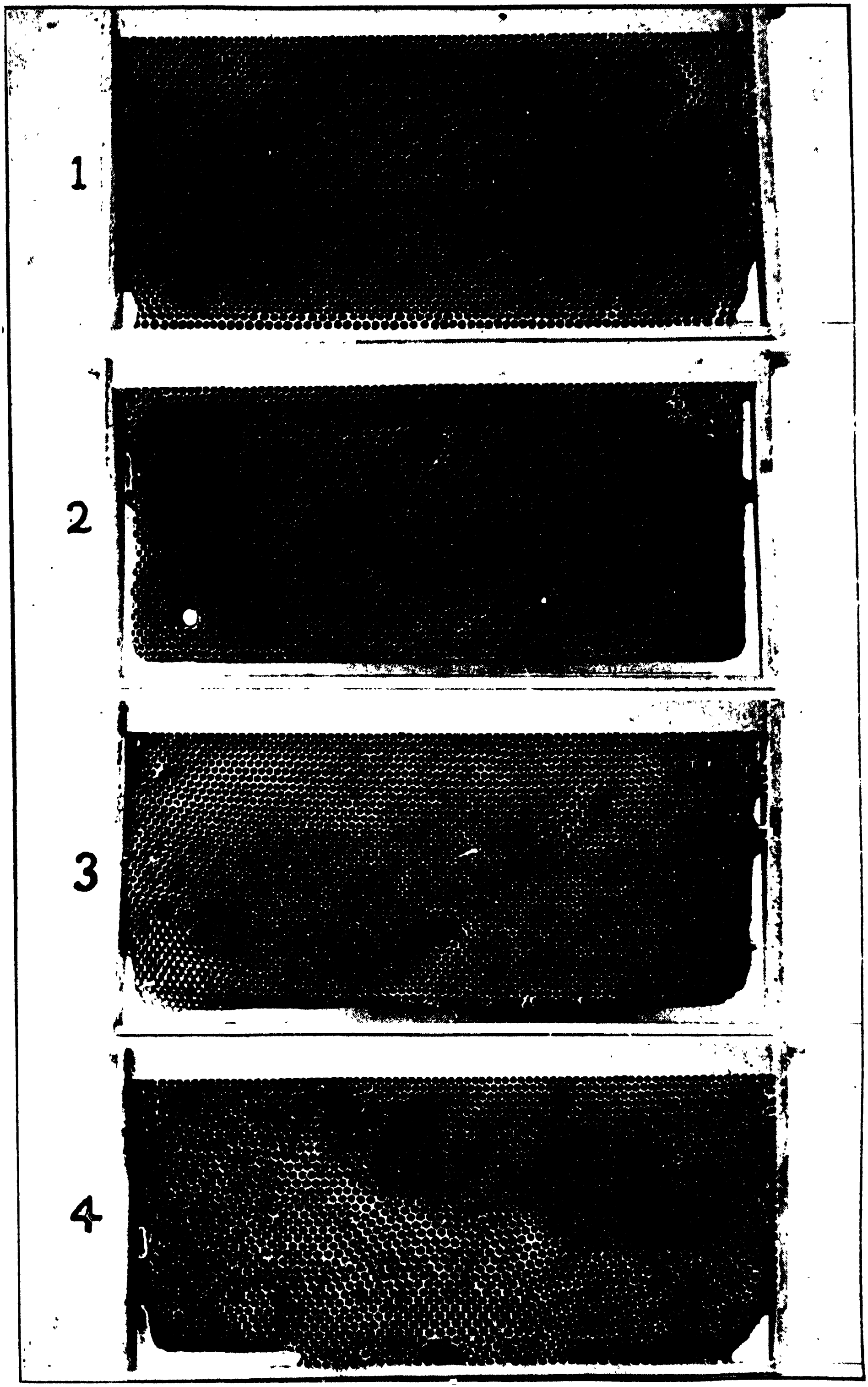
Nature left to itself is apt to be lavish in furnishing more males than are necessary. Combs in a box hive, built without foundation, result in thousands upon thousands of drones that are only consumers and thus a drain on the future food supply of the colony. The worker bees, their sisters, seem to know this; at the close of the main honey flow they push all drones out of the hive where they starve.

It has been estimated that to rear a cell of brood, either drone or worker, requires the equivalent of nearly a cell of honey of the size from which it came. A worker will be a producer as well as a consumer but a drone will only be a consumer. It is reasonably safe to say that the average drone will eat the equivalent of a cell of honey or more before he dies. It took nearly a cell of honey, plus pollen to rear him, and it will take more than a cell of honey to keep him ready for a service which a thousand to one he will not be called upon to give. If a frame of drone brood costs two cells of honey for every cell it contains, there is the equivalent of eight pounds of honey that has been worse than wasted. Every comb that contains some drone brood will contribute its quota in the wastage or loss.

The combs here shown came from a modern apiary as is evidenced by the modern Hoffman frames. These together with many more were thrown upon a pile to be melted. The owner was going through in early spring to sort out the bad combs. Spring is a good time to do this because they will then be nearly empty. Every beekeeper who has been transferring previously will get a lot of such combs that should by all means be melted for wax. This, as has been pointed out, will save honey and wasted energy of the bees in raising a hoard of drones that are unnecessary except in a queen-rearing yard. Even then only colonies having the very best queens should be used for such a purpose.

Importance of a Reserve of Good Combs

The importance of having a large stock of empty combs on hand is apparent. If one does not have the combs, how can he get them? They can be secured by giving the bees frames of foundation in the fall, when they are gathering an inferior honey. They may then be extracted and held in reserve until the main crop of white table honey comes on the following season. Or, better, if the combs are fairly well filled and sealed, he may use them for winter stores. (See Food-chambers.) Of course, one *can* have the combs drawn out during the main honey flow; but that



1, good; 2, good; 3, medium; 4, poor combs.

will probably mean some swarming and a decrease in the crop. The swarming nuisance can be materially reduced by alternating the frames containing brood with frames of full sheets of foundation. Bees will quickly draw out the combs, and the queen will enter them. This will usually check swarming; but it may mean increasing the force of bees that will come on at a time of year when they will be of little use to the colony. It may mean a reduction of the crop.

The Economic Waste from the Use of Poor Combs

At the outset mention was made of the economic difference between good and poor combs. The illustration (page 205) will give an idea of what constitutes a good comb, a medium one, and a poor one. First of all, the combs should be well wired to stand rapid handling, moving full colonies from one yard to another, and more or less rough usage in and out of the extractor. (See Comb Foundation and Extractors.) When the honey is thick the extractor must be revolved at full speed; and unless the combs are built from reinforced foundation and well wired they are liable to break out of the frames.

It is essential, also, that the comb be well fastened to the end-bars and built clear down to the bottom-bar. No. 1 is an illustration of a fairly good comb, No. 2 is fair. No. 3 is a poor one, and both 2 and 3 are defective in that they are only partially attached to the end-bars. Perhaps in a year or two during a good honey flow, the combs may be extended and attached to the end-bars. If the flow is a good one and the combs are in an upper story the bees may build them down in contact with the bottom-bars as shown in No. 1. If the comb is attached only to the top-bar, as in No. 2, there will be a bee-space next to the end-bars and the bottom-bar—just the nicest place for a queen to hide when one is looking for her.

Attachments to the bottom-bars can be made very quickly by turning a super upside down, and leaving it so for a week or two, or even twenty days, during which the bees will probably build the comb upward and attach to the bottom-bar, which is now at the top. (See Reversing.) No. 4, while fairly well fastened, is very bad on account of the presence of so much drone comb. It may be used for the production of extracted honey, but the objection to it is that the queen, unless excluding zinc is used, may go on it and fill it with drone eggs. Extracted honey can be produced in it as well as in all-worker comb, but the average beekeeper will do well to cut out any comb like No. 4 and melt it.

The ideally perfect comb is one that is built from reinforced foundation on four horizontal wires, the wires passing through the end-bars, the comb being attached to the end-bars and bottom-bars, with no holes in it.

There are about 132 square inches in the surface of a standard Langstroth comb, and this will make the average comb contain approximately 6500 worker-cells on the two surfaces, provided the comb is perfect. If the combs are like No. 4, it will be seen there is a big loss in the breeding capacity for worker brood. One may, therefore, have a ten-frame hive and still have only fifty or sixty per cent capacity for worker brood. As it takes approximately a cell of honey to raise a cell of brood, it will be seen that a given area of drone brood will mean an equal area of honey that is actually lost.

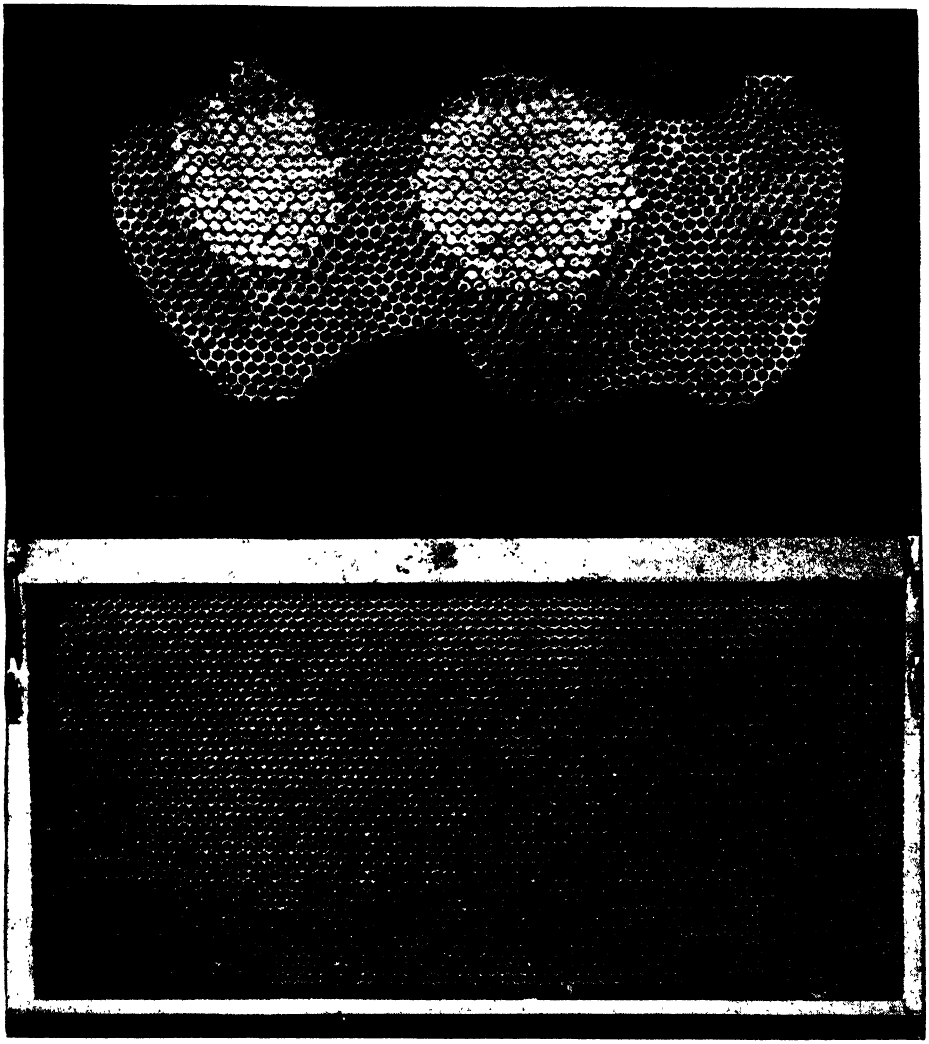
It is desirable to have combs built solid to the bottom-bar. When combs are kept in upper stories or above the brood nest, the bottom attachment will remain; but when these combs are placed in the lower story next to the bottom board the bees are quite inclined to gnaw the bottom of the comb, leaving a space between the bottom edge of the comb and the bottom-bar, as in No. 3. They will also gnaw the corner of the comb next to the entrance. Most combs have the bottom corners rounded off in this way, as shown in Nos. 1, 2, 3, and 4.

Mouldy Combs

Otherwise good combs will sometimes in the spring be covered with a whitish blue mould especially if the spring has been damp. A colony insufficiently protected by winter packing will give off considerable dampness and this dampness on the outside combs will develop a little mould. This mould will disappear after the weather warms up and the colony becomes stronger.

Combs Smeared with Dysentery Stains

Combs in a hive where the bees have died from dysentery will often be so badly stained and so ill smelling that a beginner is apt to think that they are ruined. Give all such to a strong colony in



The upper frame, by mistake, contained no foundation, although it was wired. Note the drone-cells. The lower frame had a full sheet of reinforced foundation and every cell is worker.

warm weather and it will soon clean them up and make them as good as ever.

CONTRACTION. — Along in the 80's contraction of the brood-nest during the summer seemed to be all the rage. It was argued that most colonies, Italians especially, after they had put a little honey in the brood-nest, would be disinclined to go above into the supers. To force them above, some beekeepers took out three or four of the brood-frames below and contracted the brood-nest and then placed supers on top. This was very pretty in theory, and in practice it *did* force things. It forced the bees into the supers, but more often forced swarming, and, worse, so reduced the strength of the colony that it could not store any surplus honey.

Another set of contractionists argued in favor of hiving *swarms* in a contracted brood-chamber. They did not believe in contracting the brood-nest in an established colony; and, therefore, when they contracted at all they did so only during swarming time. This form of contraction was certainly better than the other; but,

as the years go by, less and less is heard about contraction and more and more about expansion—how to get stocks strong —big, rousing, powerful colonies. (See Hives, Comb Honey, to Produce; also Building Up Colonies and Food Chambers.) An eight-frame brood-nest is usually small enough. Indeed, a ten-frame may be none too big. (See Hives, Dimensions of, elsewhere, for further consideration of this subject.)

For contraction during the winter, see Wintering Outdoors.

Excessive Contraction and How It Made Poor Seasons in the 80's

In his early experiments Langstroth found that the excess of honey in the brood-chamber previous to the beginning of work in the boxes could be greatly reduced by the use of a shallow hive. In adopting the particular depth of his hive he was greatly influenced by this fact. In effect the shallow hive cuts off the honey at the top and permits placing the boxes down close to the brood, which is so important in inducing the bees to begin work in the boxes.

Langstroth built his hive to hold 10 frames and considered this to be the best size for the production of honey in the 6 to 10 pound boxes which were the "supers" of that time.

In using the Langstroth hive to produce honey in sctions, beekeepers along in the 80's inclined to the theory that better results could be secured from the weaker colonies by removing any combs not well filled with brood at the beginning of the honey flow and filling the vacant space with wide frames, each holding eight sections, or with thick division-boards, which came to be known as "dummies." Later, the wide frames and side storing were abandoned and dummies for contracting the brood-nest became a part of the regular equipment for comb-honey production.

Reduction in the Size of the Brood-chamber

Since the majority of colonies usually have some combs not filled with brood at the beginning of the honey flow, many beekeepers in the early days reduced the size of the hive, cutting it down to eight frames, in order to make sure that most of the colonies would have their brood-chambers full of brood at the beginning of the honey flow. In this case, if any colonies should become crowded for room before the main honey flow, a comb of emerging brood could be exchanged for an empty comb from some colony with less than eight frames of brood. In other words, these beekeepers reasoned that better results could be secured through a series of years by using a brood-chamber which averaged a little too small instead of one averaging a little too large.

These problems were discussed freely in the bee journals from 1885 to 1890, at which time the eight-frame hive had practically become the standard hive in this country. It should be remembered that at this time comb honey was being produced by a great majority of beekeepers.

Later, however, it was found that the advantage of the eight-frame hives was being lost, for after a few years they in turn were no better filled with brood at the beginning of the honey flow. Within a few years beekeepers were reporting the same difficulties with the eight-frame hive that they formerly had experienced with the ten-frame hive. Instead of recognizing that the cause of the smaller colonies was the reduced capacity of the brood-chamber, with its attendant danger of a shortage of honey at the most critical periods, many beekeepers sought a remedy in a further reduction in the size of the brood-chamber. The dummies of the days of the 10-frame hive were again brought into use, and the "contraction" of the brood-chamber was advocated by most comb-honey producers.

Further Contraction of the Eight-frame Hive

This time the brood-chamber was reduced from eight frames to five frames. This contraction was done by some at the beginning of the honey flow when the comb-honey supers were put on, and by others only when hiving swarms; but since most of the strong colonies swarmed and the weak ones had to be contracted to induce them to work in the supers, most of the colonies were contracted to five frames at some time during the season, the contractionist advising that parent colonies be contracted to five frames and supplied with a super in order to utilize them as well as the swarm in honey production.

At this time many of the leaders in beekeeping in this country considered five frames to be sufficient capacity for the brood-chamber except during the period of heaviest brood-rearing just pre-

vious to the honey flow from clover, when the brood-chamber was temporarily expanded to eight frames. These things were taught in the beekeeping literature at the time; and at a beekeepers' convention held in Chicago in 1893, when the question was asked as to the proper size for the brood-chamber for comb-honey production, it was found that the majority of those present favored a brood-chamber of five or six frames capacity. In 1885 Mr. James Heddon brought out his hive, which could be contracted horizontally. (See Hives.)

Poor Seasons Followed Reduction in Size of Brood-chamber

It is not surprising that the beekeeping industry suffered a period of severe depression at about this time, for the small hives and severe contraction of that period, together with the gradual elimination of basswood and fall flowers, made the existence of colonies of bees a precarious one indeed unless much feeding was practiced. The series of so-called poor seasons in the clover regions which followed the contraction fad almost wrecked the industry in this excellent honey-producing region. Looking back now, it seems remarkable that beekeeping has even partially recovered from the terrible setback of that time.

In November, 1891, Hutchinson wrote in the editorial columns of the Beekeepers' Review as follows: "In 1888 the average yield in my apiary was 10 pounds per colony. In 1889 it was 20 pounds; in 1890 not one pound; in 1891, five pounds. * * * The honey stored in my apiary the past four years would not have kept us in food more than one year. I am forced to believe that hundreds of beekeepers could make a similar report." After some remarks about the changes in his location, brought about by better agricultural methods, he continued: "What puzzles me is that we had good crops for ten years, then poor crops for four years. It seems as though the change ought to have been more gradual."

Poor Seasons Caused by Lack of Strong Colonies

That the management was more at fault than the seasons was inadvertently shown in the same journal the next month by Taylor, who wrote as follows: "In my home apiary the past season I had one swarm for about every 25 colonies, an average of about five pounds of comb honey to the colony. But there was one colony that cast a swarm and gave a surplus of 75 pounds of comb honey over and above sufficient winter stores for the two colonies. * * * * There was no accession of bees from other colonies nor any robbing. Wherein was the power of this colony? Was it from the fortuitous conjunction of conditions at the most favorable times so as to produce extraordinary exertion at the nick of time? Did it possess a secret knowledge of some rich acre of clover in a sunny nook? Or was it possessed of inbred characteristics which gave it powers to excel? If in the first or last, as seems most likely, we have in them a rich field for exploration. He who finds out how to time the conjunction of conditions and to perpetuate the most desirable characteristics will abolish poor seasons, not simply find a doubtful remedy therefor."

Early the next year the same writer revealed this desirable "conjunction of conditions," which has since played such an important part in "abolishing poor seasons," in the following significant statement: "In the leanest of the late lean years, every colony that cast a swarm as soon as the first opening of the white clover has given me more than an average amount of surplus comb honey, and by that I mean more than an average in good seasons. Now it has come to be a fond dream of mine that all reasonably good colonies having good queens can be brought to the swarming-point by that time."

The poor seasons continued for many years in the clover region when comb honey was produced. In 1901, in a personal interview with the writer, James Heddon, who at that time was a leader in American beekeeping, stated that his location had failed during the preceding 15 years, and that he had given up hope that the state of Michigan would ever produce another crop of honey.

Good Seasons Are Returning

Gradually, however, the tide turned in the direction of better crops, as beekeepers learned to leave more honey in the hives and quit nursing along little colonies in little brood-chambers by furnishing them food on the "from-hand-to-mouth" plan. Gradually the colonies of better beekeepers have grown larger and larger until now even the 10-frame Langstroth hive has become too small in many

cases to hold all the brood of a good colony at the beginning of the honey flow, and those who are using a smaller hive now usually expect to have two stories better filled with brood at the beginning of the honey flow than was the single story of 25 to 30 years ago. The comb-honey producers of the present who are still using the eight-frame hive do not find it necessary to take out empty combs from the brood-chamber and insert dummies to fill the vacant space. Instead of this they are making increase with the extra frames of brood left over when they reduce this hive from a two-story hive to a single story at the time the comb-honey supers are put on at the beginning of the honey flow.

These changes for the better have come about so gradually that many beekeepers have failed to notice the changes in their management which are largely responsible for them, and some are inclined to believe that the seasons are growing better. Others say that we have developed better queens, which can fill 12 to 15 frames with brood instead of 5 to 8 as during the days of extremely small brood-chambers.

But to be convinced that the greater amount of stores which the better beekeepers are now leaving with the bees is largely responsible for the better conditions of today, it is only necessary to visit a few of the many beekeepers who still compel their colonies to live from hand to mouth; for some have not yet learned the lesson from the period of depression from which our industry has not yet fully recovered. (See Food Chamber.)

CORAL BERRY.—See Buckbush.

CORN SUGAR.—See Sugar.

CORN SYRUP.—See Glucose.

COTTON (*Gossypium*).—Two species of cotton are cultivated in the United States. They are Sea Island cotton (*G. barbadense*) and American upland cotton (*G. hirsutum*). Sea Island cotton yields a very fine long staple (1½ to 2 inches in length), but it is grown only along the coast of South Carolina and inland in southern Georgia, northern Florida, southern California and Arizona. Upland cotton (*G. hirsutum*) forms more than 99 per cent of the cotton crop of the United States. Two principal commercial types are grown in the United States—short-staple upland cotton (fibers under 1⅛ inches in length), which has by far the largest acreage and upland cotton (fibers 1⅛ to 1½ inches long), which is largely confined to the Yazoo Delta, Miss., a few counties in South Carolina, and the Imperial Valley of southern California. Egyptian cotton, which has a very long staple (1¼ to 1¾ inches) is grown in the Salt River Valley, Arizona.

Upland cotton (*G. hirsutum*) is a perennial but is commonly treated as an annual. It requires at least six months free from frost. The plant grows from 3 to 10 feet tall and bears alternate, palmate leaves with 3 to 5 lobes. The large erect flowers are 3 inches across and on the first day are a creamy white or pale yellow; but soon after midday they begin to turn reddish, and on the second day are a deep reddish purple. The flowers of Sea Island cotton are yellow with a reddish purple spot at the base of each of the 5 petals. The 5 sepals are united into a cup or calyx, and below the flower there is an involucre or whorl of 3 green leaf-like bracts. The involucre becomes dry and brittle and is often torn off with the boll by careless pickers.

Nectaries

The cotton plant has both floral and extra-floral nectaries. The floral nectary consists of a narrow band of papilliform cells at the base of the inner side of the calyx. The five petals overlap except at their base, where there are five small openings leading down to the nectar. These gaps are protected by long interlacing hairs, which exclude insects too small to be of use as pollinators, but present no obstruction to the slender tongues of long-tongued bees and butterflies. Trelease saw the flowers visited by many bees, and Allard saw honeybees, bumblebees, and solitary bees (*Melissodes*) enter the corolla. After the flowers have changed in color from pale yellow to red, they cease to secrete nectar, and bees pay little attention to them.

There are two sets of extra-floral nectaries—the involucral nectaries and the leaf nectaries. Below the flower there are the three leaf-like bracts called the involucre. At the base of each of these bracts there is a nectary both on the inner and outer side—six in all. The three inner involucral glands are situated between the

calyx and the involucre, and are present in both the American and Asiatic species of cotton, but are sometimes absent in individual flowers. In form they are round, shield-shaped or heart-shaped. The three outer involucral glands are at the base of the bracts on the outside. They are entirely absent in the Asiatic cottons. Greatly magnified, "they strikingly resemble a shallow round dish with the bottom covered by a layer of large shot." According to Trelease the involucral nectaries secrete nectar abundantly, which in the daytime attract bees, ants, and humming-birds, and at night two species of moths.

The leaf nectaries are located on the underside of the main rib of the leaves, and vary in number from one to five. They are absent from individual leaves and entirely wanting in *Gossypium tomentosum.* They are small pits, oval, pear-shaped, or arrow-shaped with long tails running down toward the base of the leaves. In the tropics they are soon overrun and blackened by a growth of mold. (Tyler, J. T. The Nectaries of Cotton. Bu. Pl. Ind. Bull. 131, Pt. 5, 1908.) The leaf-glands seem to be most active at the time the leaf reaches full maturity. When the conditions are favorable nectar will collect on these glands in such large drops that it can be readily tasted, and a bee can obtain its load in a very few visits. Honeybees then neglect the blossoms, and honey comes in very rapidly. The honey secured from the foliage of the cotton does not differ either in color or flavor from that gathered from the flowers. Samples submitted to the United States Bureau of Chemistry were reported to be normal pure honey.

Cotton as a Honey Plant

The surplus obtained depends largely upon locality, soil, season, and atmospheric conditions. There are many factors which influence the nectar flow and cause it to vary in different places and at different times. One of the most important factors is the soil. Cotton is grown on a great variety of soils, as sandy loams and clay loams. Rich alluvial soils and black prairie soils are admirably adapted to its culture; but by the use of fertilizers the poor pine lands of the Atlantic slope and in the vicinity of the Gulf can to made to produce a crop. Lime seems to be required, since the Black Prairie of Texas, the most important cotton area in the United States, is underlaid by Cretaceous limestone. Little nectar is secreted by cotton on light sandy soils, and even in the black-land area on the lighter soil the plant is unreliable. The growth of the plant may be as luxuriant as on the heavier soil, but no matter how promising its appearance no cotton honey is obtained. A beekeeper at Levita, Texas, states that on the river locations in the timber region he never obtains any surplus from cotton, but that five miles southward on the black land of the prairie he secures a large amount of honey. On the lighter and drier soils of the uplands the color of the honey is reported to be lighter than on the bottom-lands.

Throughout the larger part of the Atlantic and Gulf Coastal Plain cotton does not secrete sufficient nectar to afford a surplus. Opinions differ greatly as to its value as a honey plant and are often contradictory. A series of accurate observations in the different states by a flower biologist is greatly to be desired.

In Louisiana bees are said to be seldom seen on cotton, although it is the staple crop. In the Arkansas River Valley in Arkansas there is an immense acreage of cotton, and 96 pounds per colony in an apiary of 12 colonies was obtained chiefly from this source. In Pulaski County at Sulphur Springs a great amount of cotton honey is secured.

It is in Texas that cotton rises to the rank of a great honey plant, where it yields nearly one-fifth of the entire crop of honey produced in this state. Although there are 10,000,000 acres of cotton under cultivation, it is chiefly in the Black Prairie that cotton secretes nectar abundantly. To the east and to the west of this belt the honey flow shows a marked decrease. In Metagorda County, on the coast, cotton secretes nectar well only occasionally. At Bay City cotton is not dependable, but in some seasons good yields are secured from it. At New Braunfels and northward to Waxahachie cotton is the main dependence for honey. "In an average season," according to Scholl, "a good yield may be expected from cotton in the black land districts and the river valleys. Under favorable conditions it is not excelled by any other nectar yielder in the cotton-growing belt. On poor soil and on sandy land it does not secrete nectar plentifully and in some sections under certain weather conditions not at all."

Honey Flow

The honey flow may last from June until long after the first frosts, yielding in some localities as much surplus as all other sources combined. Even after the first frost, if there is pleasant weather, the bees may continue for two weeks longer to work upon the plants and make a large increase in the honey crop. Cotton yields best when the atmosphere is warm and damp. The yield is most abundant in the early morning, and decreases toward the middle of the day as the atmosphere becomes drier. In the afternoon, unless the season is very dry and hot, the yield begins to increase again. During cloudy days or when the atmosphere is damp, nectar is secreted abundantly throughout the entire day. The flow has also been observed to increase toward the close of the season.

Cotton Honey

Cotton honey is very light in color and mild in flavor when thoroughly ripened, and it compares favorably with the very best grades of honey. When first gathered cotton honey has a flavor very characteristic of the sap of the cotton plant itself, but this disappears as the honey ripens. During a heavy flow there is a strong odor in the apiary like that produced by bruising cotton leaves.

The Honeybee and the Cotton-Grower

How far is beekeeping beneficial to the cotton-grower by more effectively pollinating the flowers and increasing the number of bolls? This is a question of far-reaching importance which deserves careful attention. The percentage of cotton flowers that develop into mature bolls is generally low, a great number proving sterile. The period during which pollination is possible is only a few hours in length. The flowers open soon after sunrise, and at midday commence to wither and close in the evening when the stigma is dry. On the second or third day they fall off from the plant. The long-staple varieties of cotton are better adapted to cross pollination than the short staple. The growers of the long-staple varieties probably will find beekeeping a distinct advantage to the cotton crop. The value of honeybees in this connection is recognized in some localities.

Cotton in the Southwest

There is evidence that cotton was grown in Arizona by the prehistoric cliff-dwellers before the discovery of America. The Indians and early settlers likewise attempted the cultivation on a small scale of short-staple cotton. About 1900 a variety of long-staple was introduced from Egypt, where in the valley of the Nile it had been grown successfully for many years. At the Government Experiment Station at Sacaton a new variety known as the Pima, was developed from the Egyptian plant. No other cotton in the world has a greater length (1⅝ inches) or a greater degree of fineness. In 1911 about 400 acres of Pima cotton were planted in the Salt River Valley. This was the beginning of the growing of the long staple cotton as a commercial crop in Arizona. The acreage gradually increased until 1917, when the supply of long-staple cotton used in the manufacture of automobile tires became wholly inadequate, and the price increased to one dollar per pound. One of the large American tire companies in the spring of 1918 bought several thousand acres of land in the Salt River Valley and seeded them with the American variety of Egyptian cotton. The alfalfa growers ploughed up their fields and raised cotton instead.

The high price of cotton also greatly stimulated its production in southern California. Imperial Valley, Palo Verde Valley, and Kern County are recognized as cotton-growing centers. In Imperial Valley, California, and Lower California it was demonstrated that long-staple cotton can be grown satisfactorily. But the decline in the price of cotton checked its cultivation throughout the Southwest, and many acres in the Palo Verde Valley were not harvested.

Cotton does not yield as much nectar per acre as alfalfa, and, in localities where it has largely supplanted alfalfa, beekeepers are not securing as large a surplus as formerly.

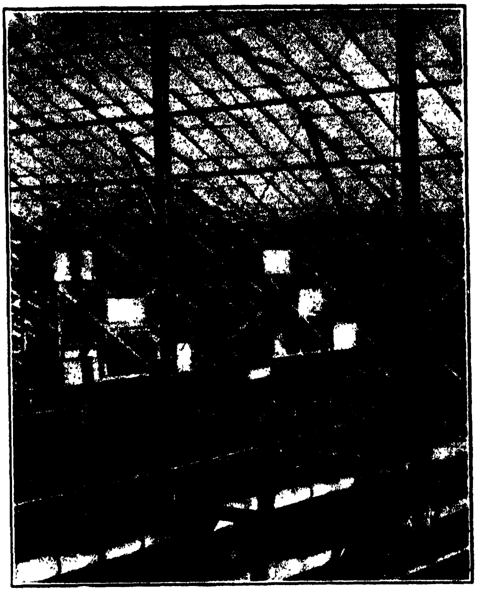
See "Honey Plants of North America."

CRIMSON CLOVER.—See Clover.

CROSS BEES.—See Anger of Bees.

CROSSES OF BEES.—See Hybrids.

CUCUMBER (*Cucumis sativus*).—In the vicinity of pickle factories where there are large acreages of common cucumbers considerable cucumber honey is secured. It is a yellow or amber and of medium



A part of the "apiary" located above the wires.

quality; but perfect cucumbers can not be grown either in open fields or under glass without the aid of bees. In the absence of bees cucumber blossoms remain barren and the fruit is scarce or imperfect. The stamens and pistils are on different flowers. Resort must be had to either hand pollination or to bees. The former is expensive and therefore bees are almost always used and are indispensable for perfect cucumbers.

In some of the large greenhouses where cucumbers are grown large numbers of bees are used. While the loss of bees is considerable because of their vain attempts to go through the glass, this loss is made up by fresh shipments of package bees from time to time. (See Package Bees.)

Package bees from the southern states to the cucumber greenhouses north has come to be quite a business. (See Fruit Blossoms, at the close of the article.)

CYPRIAN BEES.—See Italians.

D

DAISY.—See Asters.

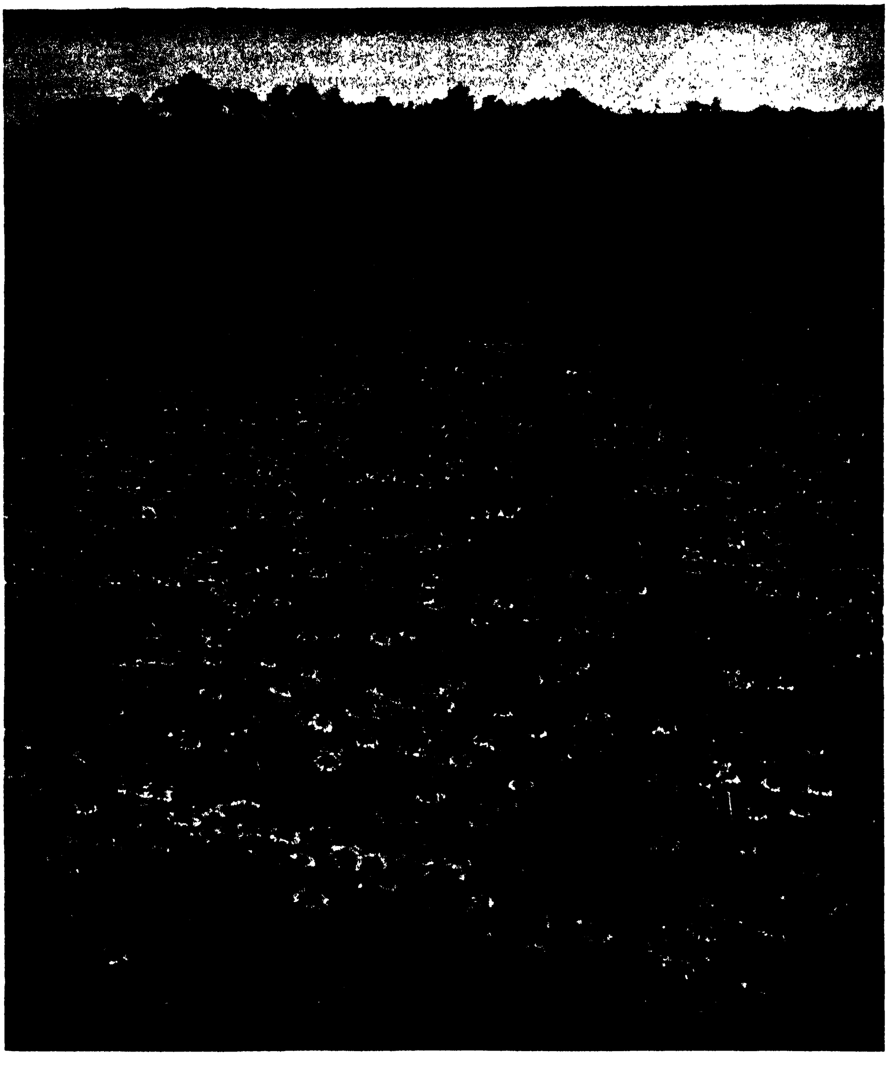
DANCING BEES.—See Bee Behavior.

DANDELION (*Taraxacum officinale* Weber.)—Other English names are lion's tooth, blowball, yellow gowan, and priest's crown. It is widely distributed over Europe, Asia, North America, the Arctic regions, and in many other parts of the civilized world. At Medina, as is shown in the photograph, and in many other localities the flowers are in some years so abundant that the fields and lawns are an almost unbroken sheet of golden yellow. The effect is most cheerful and pleasing, and in its season there is no other wild flower that can vie with the dandelion for ornamental purposes on a large scale. Coming as it does in early spring, preceding fruit bloom, it is a most valuable plant for bees. Some seasons it furnishes not a little honey, and besides it affords a large amount of pollen at a time when bees require a rich, nitrogenous food for brood-rearing.

The dandelion belongs to the Compositate, and is related to the hawkweed and chicory. The head or capitulum consists of from 100 to 200 florets. The corolla of each floret is strap-shaped, but at the base unites to form a short tube which holds the nectar. At night and in damp weather the head closes so that there is little visible except a protecting whorl of green bracts. The pollen and nectar are thus completely sheltered from dew and rain.

A dandelion lover.

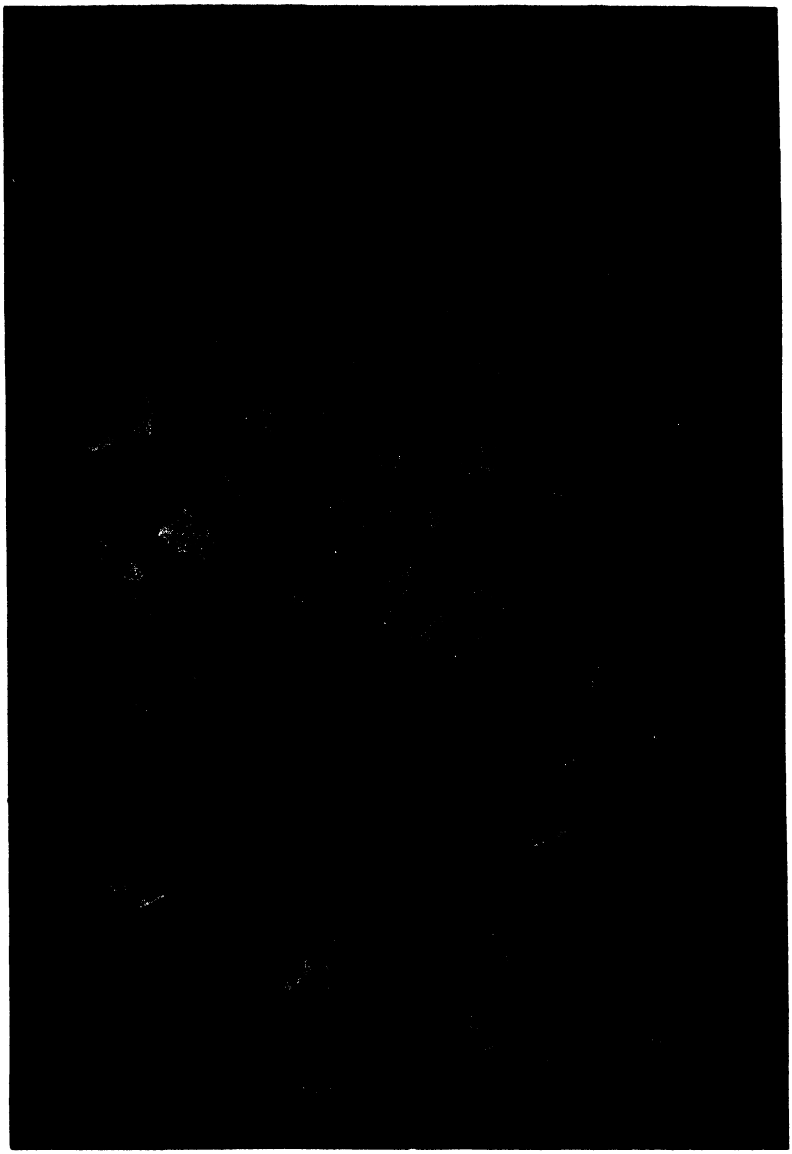
In many widely separated localities a surplus of dandelion honey is not infre-



A part of a field of dandelion in full bloom at Medina. This, and other fields like it near Medina, furnish considerable honey and pollen in early spring—just when they can do the most good. We do not find that the plant hurts the hay or pastures in the least.

quently obtained, and occasionally it is placed on the market. In Colorado it is common for the hives to be filled with dandelion honey, and a few beekeepers have offered the extracted honey for sale. Finished sections can also be produced. But most of the dandelion honey gathered is consumed in the hives before alfalfa begins to blossom. In many locations it is more highly prized than fruit bloom. In Vermont, hive after hive is filled with dandelion honey; and, with the exception of the clovers, it ranks with the best honey plants of this section. Although it does not possess a fine flavor, it is used as a breakfast honey. On many farms in Ontario and Quebec dandelion produces more honey in early spring than any other plant. It is apparently rapidly spreading, both in Canada and the United States, and becoming yearly of more importance to bee culture.

The flow from dandelions in May lasts for about two weeks, and is increased by a succession of warm days. The honey varies in color from bright yellow to a



A large specimen of dandelion blossom, buds, and leaves—life size. The blossom here shown is larger than the average. The usual size is about two inches across.

deep amber—a little darker than that of goldenrod. Comb built when bees are working on dandelion is a beautiful shade of light yellow, even the older comb becoming yellowish. When newly gathered the honey has the strong odor and flavor of the dandelion flower; but when fully ripened it has an agreeable taste, although persons accustomed to a mild honey might consider it too strong. If the brood-chamber is crowded with it, it is likely to be carried up into the super, injuring the quality of the surplus. It is thick and viscous, and crystallizes with a coarse grain in a short time. It would seem as though a variety of this species might be obtained which would yield nectar freely over a wide area.

The dandelion has both beauty and utility, and an attempt to exterminate it,

even if this were possible, would be a grave mistake. "Of the attractiveness of the bloom there can be no doubt. Attentively considered, it will be seen that it is a model of symmetry." It is of no injury to the hay fields, and as a pasture feed it increases the flow of milk and improves its quality. Tons of the leaves, both wild and cultivated, are boiled as "greens" and afford a palatable and wholesome food—to be had for the gathering. Large quantities are also salted for winter use. The roots serve as a tolerable substitute for coffee, and are reputed to be of medicinal value in cases of disordered liver. The seeds are eaten by poultry, and even the flowers are occasionally utilized.

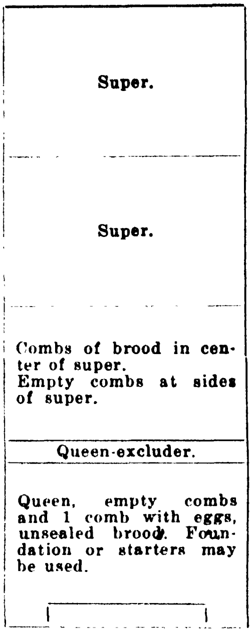
But more than one futile crusade has been organized against the dandelion based on the complaint that it is a pestiferous weed in lawns. However, a rich soil and a dense turf will do much to eradicate or exclude it; but happily nature has made its wholesale extermination difficult. Contrary to general belief, it can be killed in most cases if it be cut off level with the ground. If this is not effective a drop of kerosene applied with a spring top oil-can will do it. If the dandelion is not invulnerable, it is invincible. Said A. I. Root: "This plant has been called only a pest, but it is one of God's greatest and most precious gifts in making our northern Ohio clay soil 'a land flowing with milk and honey,' and both at the same time."

DEMAREE PLAN OF SWARM-CONTROL.—This general heading might more properly be considered under the subject of Swarming, subhead Swarm-control, but inasmuch as the Demaree plan involves several different methods, it has been thought best to avoid confusion by putting the general discussion under this head, giving only one method (the best one) under Swarming.

The Demaree plan, so-called, has been mentioned in bee literature for the last fifty years. Inasmuch as Mr. G. W. Demaree, the author of it, changed his plan several times, improving it, the reader may desire to know the history, as the principles are in general use.

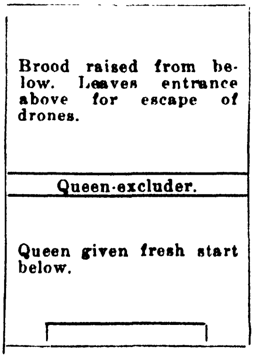
In brief, the Demaree plan means any method for expanding the brood-nest by transferring the brood or the queen from one brood-nest to another and then confining her activities to one particular brood-chamber (usually the bottom one) by the use of a queen-excluder for the purpose of the prevention or control of swarming.

The Demaree plan is not adapted to the



Demaree's plan of 1892 for prevention of increase. Applied to strongest colonies at commencement of swarming, but usually before appearance of any queen-cells. If applied after swarm issues, no brood or eggs are left in brood-nest.

brood-chamber of a Jumbo or larger hive. It is usually confined to a hive of Langstroth dimensions, involving two or more stories, and those stories may be either 8-frame or 10-frame. As the 10-frame hive is almost universal, the several dif-

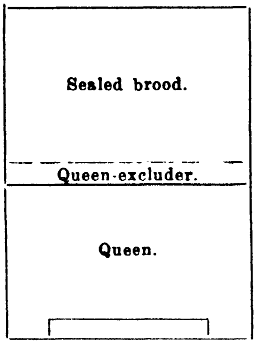


Demaree's plan of 1894, for swarm prevention. All brood raised.

ferent methods of "Demareeing" a colony are applied to that hive.

Mr. Demaree first began talking about swarm-control as early as 1884. (See American Bee Journal for that year,

page 619.) In 1892 in the same journal, page 545, he first described the scheme bearing his name for the control of swarming. At that time he took only the strongest colonies in a single brood-chamber and lifted the combs containing brood from the lower chamber to an upper story, with a queen-excluder between. One comb containing some unsealed brood and eggs with the queen he left in the lower chamber. The balance of the space in both stories was filled out with empty combs, or with frames containing full sheets of foundation. If honey was coming in, then one or more supers of empty combs were added on top.



Demaree's plan of 1895. For no increase he used above plan. For increase, allowed to swarm, shaking some bees from old colony into new.

In 1894 he modified the plan by putting all the brood above in the second story, the queen below the excluder on empty combs. He then made a small hole in the upper story so that drones could escape, thus preventing a congestion of dead drones upon the excluder between the two stories. In 1895 he again modified the plan by putting all of the sealed brood upstairs and the queen and the unsealed brood downstairs.

In all of these three plans it will be seen that the congestion of the brood-nest was relieved, (1) by putting the queen in new quarters where she would have plenty of room; (2) placing the emerging brood in the upper story away from the brood-nest proper, and (3) giving room for the flying or field bees to store their honey. With all the sealed brood upstairs, the emerging brood would gradually make room for the storage of honey. In the meantime, the brood below would be sealed and finally young bees would emerge, adding to the others. The upper story that had contained the sealed brood would be filled with honey and more supers could be added. This is exactly what takes place when a colony swarms, with this advantage: the parent colony and the swarm are together.

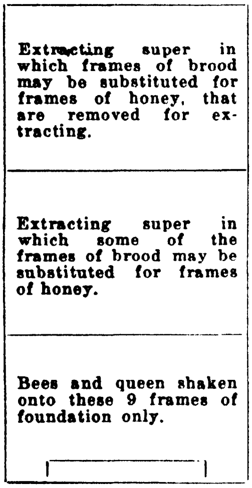
By turning to the general subject of Swarming it will be found that the main causes of swarming are a congestion of the brood-nest, the queen honey-bound, too many young bees in the lower story, and the flying bees cramped for space in which to store their honey. The Demaree plan, in a word, relieves both the queen and the worker bees, provides extra room for the rearing of more brood and extra room for the storage of honey. It likewise places the force of young bees (an important cause of swarming) upstairs where they can receive and store the honey in the cells, draw out comb if necessary, and then finally seal the honey. When there is a large force of young bees in the brood-nest where the brood is being reared, and the queen is cramped for room, queen-cells are liable to be built and are built, and general preparations are made for swarming.

It will be seen that several modifications of the plan can be made by any intelligent beekeeper who can grasp the general principles involved. The author some years ago unwittingly adopted the 1895 Demaree plan. He came across one of the outyards where the colonies were strong in single-story hives, brood was getting to be congested, the bees were needing room, and the honey flow was about ten days off. Having on hand at that yard extra supers with drawn combs, all the combs of sealed brood were lifted into an upper story, where they were crowded together in the center. The unsealed brood with the queen was placed in the lower story. The space on either side of the brood upstairs and downstairs was then filled with empty combs. A queen-excluder was placed between the upper and

Langstroth's plan of 1865 for prevention of increase.

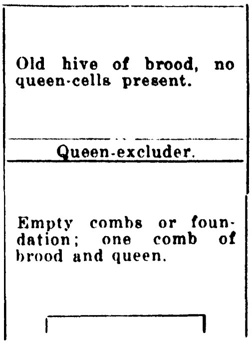
lower story. In a couple of weeks thereafter it was found that all the brood had emerged from the upper story, and the combs were filled with honey. The lower story had mostly brood in all stages. Where this condition was found, a super of empty combs was placed between the upper story and the brood-nest proper, leaving the queen downstairs where she had been. From time to time supers were added until the close of the season, when the bees were made to complete the supers already partially filled.

By turning to Building Up Colonies, Food-chamber, and Comb Honey it will be noted that in most of the modern apiaries it is coming to be more and more the practice to allow the queens to have



Plan of Samuel Simmins of 1884, for prevention of increase. May place brood above or give to other colonies.

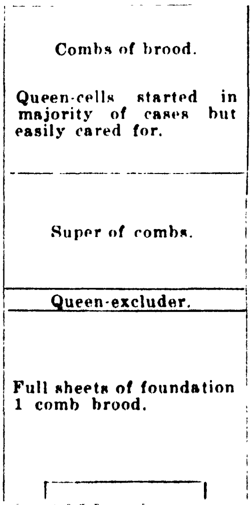
the range of two Langstroth brood-chambers after the first of May. Where a food-chamber is used there will be two stories to begin on. If the bees are wintered in a single story, another story of empty dark combs should be added as soon as the queen occupies seven or eight frames of brood. The queen will soon work upward and begin work in the upper story; and when this is well occupied with brood she will work downward into the lower story. As soon as the season advances, and perhaps a few days before the actual honey flow, there may be as high as fourteen or fifteen frames containing brood in the two stories. The common practice is to put all the sealed brood upstairs above an excluder and the unsealed downstairs with the queen. As the brood emerges from the upper story, room will be automatically provided for the storage of honey. When this is partially filled, an empty super is placed underneath. It will be observed that the



Alexander's plan of 1906, requires three or four manipulations. Applied when about populous enough to swarm. After five days, if queen-cells are present, destroy and separate at once. If no queen-cells, leave 10 or 11 days and then put old hive on new stand. In 24 hours, give ripe cell, virgin, or laying queen.

Demaree plan works admirably in all cases where brood is reared in two stories to accommodate a first-class queen, as is now the universal custom with large producers.

There are other modifications of the Demaree plan. One is by Samuel Simmins, of England, a well-known writer on the subject of bees. Instead of dividing the brood into two stories, he provides a brood-nest with frames of foun-



J. L. Byer's plan of 1914, for swarm prevention. Applied before swarming fever shows.

dation, puts the queen below, and on top of this a queen excluder, and on top of this again all the brood with some frames of honey. He modified the plan still further by shaking the bees below onto frames of foundation and then putting section supers on top.

Mr. E. W. Alexander, then of Delan-

son, New York, put a frame of brood in the lower story, filled out the space with empty combs or foundation, and then put all the brood in an upper story over a queen-excluder.

Mr. J. L. Byer's plan was similar to this, except that he put above the queen-excluder a super of combs and then the brood in the top story. This is practically the same plan that was adopted by Chalon Fowls, of Oberlin, Ohio. The Byer and the Fowls plan make it possible to secure increase. Queen-cells will be started in the upper story if they have not already been started, because the young bees removed so far away from the brood will build cells. When cells are nicely under way and sealed, the upper story can be lifted off, and in the meantime a large portion of the emerging bees will have joined the force of the bees below. The removed brood and adhering bees can be placed on a separate stand, where increase is desired.

Where increase is not desired the brood is allowed to emerge in the top story and in seven or eight days all cells are destroyed. This general procedure has the merit of placing all the young or nurse bees in the top story, where they can not be the cause of swarming. The field workers will be downstairs with the queen where there is plenty of room for her to expand her brood. The nurse bees will finally be old enough to become fielders and join the honey-gathering bees.

Under Food-chamber, Comb Honey, How to Produce, and Swarming, will be found other plans of Demareeing that are similar, and in some cases the same as those already described.

DEVELOPMENT OF BEES. — See Brood-rearing.

DEXTRIN.—This may be regarded as an intermediate product between starch and the sugar dextrose. When starch is treated with dilute acid, or acted on by heat or by certain ferments, it becomes soluble in cold water and loses its gelatinous character. It is then dextrin. Dextrin is found in all starchy foods which have been considerably heated, viz., toast and brown crust of bread. It is produced commercially for use as an adhesive. Postage stamps and gummed labels are nearly always coated with dextrin. Dextrin is found to a large extent in commercial glucose or corn syrup and to a very small extent in normal honey. Honeydew honeys contain larger amounts. (See Sugar, also Science of Honey.)

DEXTROSE.—This is the name of one of the five common food sugars. It is variously termed dextrose, starch sugar, corn sugar, grape sugar, or glucose. It occurs in honey, of which it constitutes a little less than one-half the solid part. It is also found in many fruits, notably grapes; hence the name, grape sugar. Commercially, it is to be found in invert sugar, of which it constitutes one-half, and in commercial glucose or corn syrup, where the proportion is somewhat smaller. It is interesting to note that practically all the starch we eat is converted into dextrose during digestion. (See also Invert Sugar and Sugar.)

DIABETES.—See Honey as a Food.

DIAGNOSING COLONIES.—The term "diagnosing," when used in bee culture, applies to a method or methods of determining the internal condition of a colony from surface indications, mainly at the entrance, and without opening the hive. In the height of the honey flow, expert beekeepers, when rushed with their work, can tell pretty accurately what colonies in the yard are or will be needing attention by a glance at the hive. The knowledge of how to do this enables the expert to administer treatment at once to colonies that would be likely to swarm and go to the woods during his absence, or which might otherwise begin to loaf for the simple reason that they would not have sufficient storage space. When bees are crowded for storage room they will even occupy cells that the queen would use for breeding; and the result is she is so cramped for space in which to lay eggs that she is "honey-bound". If the honey flow continues there will not be young brood to come on to supply bees to care for the late flow.

All this goes to show the necessity of giving the powerful colonies room when they need it. To go through every hive comb by comb, in the height of the season would be impossible; and so the expert beekeeper picks out by surface indications first those colonies that need attention at one or more of his yards, then, later on, takes care of those that are in no urgent need of care. But knowing

how to pick out those that will swarm or waste valuable time in the height of the season is a trick of the trade worth knowing. Even the beginner who has only a few colonies will find that, after a little practice, he can pick out his best ones by looking at the outside. If Mr. Beginner is a professional man, busy during the hours of the day with other work, he can, at his odd moments at home, tell which colonies should have immediate attention. This saves his time, of which he may not have too much at his disposal.

How to Determine Whether a Colony Needs Room

Now then for the "know how". The most reliable indication of what a colony is doing or will do is the flight of the bees going in and out of the hive. If one colony, for example, has its bees pouring in at the entrance by the score, and coming out in the same way, and another one right by the side of it has only one-half or one-fourth as many going in and out, it is very evident that the first mentioned is very strong and will shortly need room, even if it does not already. The last-mentioned colony may have a poor queen. It may have had poor food during the winter, or insufficient protection. It will probably have only about one-half or one-fourth as many flying bees. It will not need more room, and for the time being can be allowed to take care of itself. The other colony, with its busy rush of bees going in and out, should be opened. If it has little spurs of wax built along the top edges of the comb, if it is full of brood, and if, further, storage space is being cramped, another super should be added. It is possible, if the weather is getting hot, that the entrance should be enlarged. (See Entrances.)

At the same time that the entrances of the strong flyers are being observed it is advisable to get back of the hives of such flyers and, by hefting, see whether the hive is getting heavy. With a little practice one can get a pretty fair idea of the amount of honey in the hive by lifting or attempting to lift the back end of the hive. If the bees are flying strong, and the hive seems light, it will, of course, have plenty of room for the storage of new honey. But if it feels heavy, or too heavy to lift, then, of course, room should be given at once.

In like manner the apiarist should go through the whole apiary, walking down the rows, carefully inspecting the entrances and hefting the hives. In five minutes' time he can go through 100 colonies, laying a stick, block, or a small stone as a distinguishing mark on top of the strong flyers and heavy hives. All others he will ignore for the time being. He or his man will then proceed to examine the indicated colonies first. These may use up all extra supplies he has brought with him, if it is an outyard. Later on, when he has more time, he can take care of those that are not flying strong to determine whether the queen herself is inherently poor or whether the colony did not have a fair chance at the start on account of insufficient protection or poor food. If it is a nucleus or a late swarm in the fall, no matter how much protection it might have, it would have insufficient bees to protect it.

Play Flights Misleading

At this point the beginner, at least, should make a careful distinction between the playflights of young bees (see Playflights) and bees that are rushing to and from the fields. In the case of the former the bees will be seen flying nervously around the entrance, some going in and some flying aimlessly around in the air for several minutes near the front of the hive. When busy at work going to the fields they will fly from the entrance directly to some distant point, as soon as they rise above surrounding objects. In the same way they will come in from the field, going directly into the entrance, or perhaps dropping on the alighting-board or ground near by if heavily laden.

Neither must the beginner mistake a case of robbing for bees that are actually at work in the fields. When the colony is being robbed out, only one hive, or at most two or three, in the apiary will be involved. The sound of robbing is quite different from the sound of actual workers. In robbing, the bees stealthily dodge in at the entrance as if they expected to be grabbed by the defenders of the home. Real busy honest workers going to and from the fields show no such dodging or nervousness. (For the behavior of robber bees, see Robbing.)

How to Detect Inclination to Swarm

A surface indication of natural swarming is a large bunch of bees—three or four quarts of them — clustered closely around the entrance of the hive during

the middle hours of the day, with only a few bees flying to and from the field. This big crowd of bees out in front means nothing if the weather is excessively hot and there is no honey flow on at the time. If the entrance is small a strong colony will cluster out in front during very hot weather, and it may do so during a honey flow toward night, but not usually during the day unless the hive is out in the open exposed to the boiling rays of the sun. In that case, shade-boards should be applied and the entrance should be enlarged. (See Shade-boards under the head of Apiary, also Entrances.)

If the colony persists in clustering out in front during the time when other bees are actively going to the fields, and not many workers going in and out, it may indicate that the bees are preparing to swarm. An examination of the hive will probably show swarming-cells more or less toward completion. Merely cutting out the cells may not prevent swarming. If the entrance has not been enlarged, treatment should be applied as recommended under Swarming, subhead, Prevention of Swarming.

During very hot sultry weather in the height of the honey flow, half of the best colonies in the apiary may have a quart of bees clustered out in front at night. This indicates nothing abnormal; for when all the field bees are in the hive there is not room enough to accommodate them and yet provide proper ventilation.

When everything is progressing normally, and the colony is doing just what it ought to do, there will be a contented roar at the entrance of each colony gathering honey. This is especially noticeable at night. If a match is ignited and held near the entrance it will be found, by the direction of the flame, that the air is going in at one side and coming out at the other side of the entrance. The contented roar one hears in an apiary where the bees are evaporating nectar into honey can be observed distinctly as one goes through the yard. It is a kind of noise that is sweeter than music to the owner of the bees. They have toiled hard during the day, and are now working to evaporate the nectar that they have gathered. At the same time that they evaporate they are ripening and converting the nectar, or sucrose, into invert sugar, or honey. The mere fanning at the entrance only eliminates the surplus of water. It is an indication that the colony during the day has done enough work to require night work. This contented roar that one hears in front of a strong colony occurs only during the height of the honey flow or during excessively hot weather, when there is no flow on. But the roar of honey evaporation, or nectar evaporation, rather, is much more pronounced than the buzz or noise from a hive on account of the heat. A colony can not stand a higher temperature, no matter what the weather is, than 97° F. (See Temperature.)

The Presence and Kind of Queen

There is another indication of the internal condition of the colony, and that is the way bees carry in pollen. It was formerly held that they would not bring in pollen if a colony was queenless. This is true only in part. When it needs pollen it will bring it in whether there is a queen or not. But a colony that has a good queen, and plenty of room for breeding, will require much more pollen than one that has no queen or a poor one. When it is possible to see many busy flying bees going into the hive, and a great deal of pollen going in, it indicates that that hive probably has a good queen, and that breeding is progressing in a perfectly normal manner. But when little or no pollen is coming in, and the bees are not flying much, it shows that the colony did not have a fair chance during winter or spring, or that it has a poor queen. On the other hand, the colony may have ever so good a queen, but if there is any large amount of foulbrood, either American or European, there will be but little need of pollen.

Dead Brood at the Entrance

If one can tell the difference between a young baby queen and young workers dead at the entrance he will be able to tell whether supersedure is taking place within the hive. If the old mother fails the bees will proceed to raise a number of cells. The first virgin that emerges will be quite liable to puncture the cells of all of her rivals and sting them. These victims will be thrown out at the entrance, clearly indicating that some young miss is boss of the ranch.

An inspection of the entrances will likewise show, oftentimes, whether a colony is on the verge of starvation, whether its brood has been chilled or overheated, or whether there are moth worms in the

hive. When several full-grown larvae or perfectly formed young bees, brown or yellow, are found dead in front of the entrance, it may indicate any one of the possibilities just mentioned. When the bees are on the verge of starvation they will not only stop brood-rearing but they will carry out their young larvae. They apparently go on the principle that they should save able-bodied living bees rather than to lose all in the attempt to raise the babies.

In early spring some of the young brood near the outside edges will become chilled. This brood will be taken out of the cells and deposited in front of the entrance. At other times, if the hive entrance should be closed for a short time on a very hot day so that the bees are on the verge of suffocation, not a little of the brood will be overheated. That which dies will be carried out in front.

When the moth worm is present (see Bee Moth) some of the brood will be destroyed along the line of the galleries made by the worms. The bee larvae will be deposited in front of the entrance the same as larvae dead from any other cause.

The presence of dead young brood out in front of the hive is always an indication that something is wrong. When it is dead from overheating or chilling there is nothing that the apiarist can do, because the damage is already done; but when it is dead because of near starvation, colonies should be fed at once. (See Feeding.) In the case of the wax moth, the galleries should be removed as soon as it is convenient to do so.

Winter Diagnosis

During winter and early spring one can often get a very fair idea of what is taking place in the colony by entrance diagnosis. If the front of the hive and ground in front are spotted with yellow, yellowish-brown, or brown or black spots, and if, further, there is a large lot of bees out in front with abdomens looking greasy and black and much distended, it shows the presence of dysentery, and probably no attention need be given because nothing can be done, since the colony will die away, in all probability. Before that takes place, the entrances should be closed to prevent robbing.

During late winter or early spring, in front of some of the best colonies may be found perhaps a hundred or more dead bees. If their bodies are shrunken, and if there are no yellow or brown spots, it may be assumed that the colony is in a prosperous condition, and that the dead bees in front are only the superannuated that would have died anyway. Beginners very often ask, when they see dead bees in front of a hive, what the matter is. The fact is, there is nothing wrong. If, on the other hand, there should be a quart or two of dead bees, their bodies ill-smelling, it would indicate that the colony is not wintering as well as it should. Usually when there is an abnormal number of deaths, it is because dysentery has been induced by insufficient protection or poor food, or because the well-meaning owner has been tinkering with his colony during midwinter to see how it is coming on.

During late winter or early spring it is not advisable to open the hives any more than is absolutely necessary. This "necessary" should be only when the colony needs feeding.

To determine which colonies are running short, it is advisable to lift up the back of the hive.

Adult Bee Diseases

The presence of bee paralysis or of the disappearing disease can be determined by the behavior of sick bees in the grass near the entrance. Bees affected with paralysis have swollen bodies looking something like those that are affected with dysentery. Occasionally they will void a yellowish transparent fluid, but not an opaque yellow, a brown or black substance such as appears in the case of dysentery. (See Dysentery.) Bees affected with the disappearing disease *(Nosema apis)* show no swollen abdomens. They will run at a furious pace in the grass, some of them crawling up on spears of grass and weeds, and finally dying. For particulars of how to treat, see Diseases of Bees.

Foulbrood Detected by the Odor

The presence of American foulbrood in an advanced stage can sometimes be detected by the odor at the entrance of a hive affected. When one finds, as he goes through the apiary, an odor resembling that of an old gluepot, having some suggestion of spoiled meat, he will do well to place his nose near the entrance of some of the colonies. The author has on one or two occasions discovered the presence of foulbrood by the odor at the entrance, even when an examination of the

combs for the time being failed to reveal any dead larvae in the cells. Such diagnosis for foulbrood, however, is by no means reliable; but when the familiar odor is detected near a hive, all colonies near by should be examined.

Occasionally the old queen may be found dead in front of the hive. If it is during the spraying or dusting season it may be surmised that she was killed by one of the poisons used for fruit trees, to kill the coddling moth. (See Fruit Blossoms and Poisoned Brood, under Foulbrood.) The hive should be examined at once, and either a laying queen or a ripe cell be given.

Checking Up Surface Indications

So far, surface indications at the entrance will indicate to an expert, and even to a beginner who has made a study of the matter, how to determine which colonies will need attention first, or what is the probable condition of any or all of the colonies. Except in the case of hunting for positive evidence of foulbrood, either American or European (see Foulbrood), it is not necessary to examine every square inch of comb or brood. A good beekeeper will diagnose his colonies first by the entrance. He will then, if necessary, get a much closer knowledge of what a colony is doing by looking at a single frame of brood in the center of the brood-nest. A quick glance at this frame will show whether the queen is a good or a poor one. If in a little doubt after examining the first frame, he may pick out another frame, after which he will apply treatment if any is needed. (See Brood and Brood-rearing.)

In short, when a beeman goes through his apiary he should use methods which will give him a knowledge of his colonies and what they are doing—in as short time as possible. In this way he saves labor and will increase his profits.

The author has personally handled several outyards, largely by surface indications, or, as here defined, diagnosing from the outside. By placing a stick, stone, or other identifying object on top of the hives that needed attention at once, as determined by surface indications, he would manipulate only those colonies, and leave the rest alone until they could work up to a pitch when they likewise began to show they were doing business.

DIASTASE IN HONEY.—See Science of Honey.

DISEASES OF BEES — A few years ago it was believed that bees were freer from disease than perhaps any other class of animated nature, for the reason that individual members of the colonies were so constantly giving way to the younger ones. But this has been shown to be, to some extent at least, a mistake. Actually there are at least three or four distinct diseases with which the beekeeper must contend. The time to cure a disease of a contagious character is to take it at the start, or, better still, take precautionary measures such as will prevent its making even a beginning.

How to Avoid Disease

Contagious diseases spread very rapidly among bees, just as they make rapid headway in crowded centers of the human family. Unfortunately, bees are disposed to rob from each other during a dearth of honey; and, if the germs of disease reside in the honey, they may be scattered over the entire apiary in a few days. Any infected colony is naturally weakened and discouraged, and as a result the bees do not make the defense that they would under normal conditions.

One of the best precautions against disease is good food, and keeping all colonies strong. A healthy human being is much more able to resist the germs of infection than one who is "all run down." A person, for instance, is not likely to come down with typhoid fever unless his resistance is greatly reduced.

Two Classes of Diseases

The diseases with which the beekeeper has to contend may be divided into two classes—those that affect the mature flying bees, and those that attack the brood. (See Foulbrood.)

Among the diseases that attack the mature bees may be mentioned "spring dwindling." This, perhaps, should hardly be considered a disease, but it is a malady with which one has to deal. Still another trouble is dysentery. This in some cases may be a germ disease, and in most cases assumes the nature of ordinary diarrhea. (See Dysentery.)

There are several other forms of adult bee diseases so similar in some respects that one has often been mistaken for the other. They may be named in inverse order of their virulence as follows: Bee paralysis, disappearing disease *(Nosema apis)* and the Isle of Wight disease. The first two are somewhat similar, but enough

different so that one can be easily distinguished from the other. The cause of bee paralysis, the least destructive, is unknown. The cause of the second disappearing disease is generally believed to be *Nosema apis*, a protozoan that attacks the lining of the intestinal tract. Large numbers of specimens of bees affected with the disappearing disease have been sent to the Bureau of Entomology for examination. The report has come back in most cases that *Nosema apis* has been found.

In the case of the third disease, known as the Isle of Wight disease, the most destructive, we have reliable and definite information. The real cause has been found in a mite that infests the breathing-pores of the bees. We will first describe

Bee Paralysis

This is a disease that is much more prevalent and virulent in warm than in cold climates. Almost every apiarist in the North has noticed at times one or two colonies in his apiary that show bees affected with it. Yet it seldom spreads or makes any great trouble in the northern states; but, unfortunately, this is not true in some parts of the South and West. In the South it has been known to affect whole apiaries, and seems to be mildly contagious.

Symptoms

In the early stages an occasional bee will be found to be crawling from the entrance, with the abdomen greatly swollen, and will have a black, greasy appearance. While these sick bees may be scattered through the hive, they will sooner or later work their way toward the entrance, evidently desiring to rid the colony of their miserable presence. The other bees also seem to regard them as no longer necessary to the future prosperity of the colony. In fact, they will tug and pull at them about as they would a dead bee until they succeed in getting them out in the grass, where the sick bees seem willing to go and die alone.

Another symptom is, that the bees often show a shaking or trembling motion. Along with this is a slow sluggish, listless movement of the legs until the specimen dies. It is quite different from disappearing disease, or *Nosema,* because it does not disappear nor do the bees run like crickets.

Treatment and Cure

In most cases, destroying the queen of the infected colony and introducing another from a healthy stock affects a cure. This would seem to indicate that paralysis is constitutional, coming from the queen; but in the South, where the disease is much more prevalent and destructive, destroying the queen seems to have but little effect. Spraying the combs with a solution of salt and water, or of carbolic acid and water, has been recommended; but these do little or no good. One writer recommends removing the diseased stock from its stand, and putting in its place a strong healthy one. The affected colony is then removed to the stand formerly occupied by the healthy bees. He reports that he tried this in many cases and found that an absolute cure followed in every instance. The rationale of the treatment seems to be that the bees of the ordinary colony having bee paralysis are too much discouraged to remove the sick; as a consequence, the source of infection—that is, the swollen, shiny bees—are allowed to crawl through the hive at will. But when the colonies are transposed, the healthy vigorous bees of the sound stock carry the diseased bees entirely away from the hive. The sick and the dying removed, the colony recovers.

Bee Paralysis in Australia; Developing a Strain of Bees Immune to It

As already mentioned, bee paralysis seems to be more virulent in hot climates than in cold ones; and it also appears that some strains of bees are less immune to it than others. F. R. Beuhne, of Tooberac, Australia, one of the most extensive beekeepers of that country, has had a very large experience with it. But Mr. Beuhne has it well under control by developing and propagating a strain of vigorous leather-colored Italians. He finds yellow strains are not very resistant to the disease. It appears that, by paying careful attention to breeding, the tendency to contract this disease may be almost entirely eliminated, and Mr. Beuhne has succeeded. On one occasion he had shipped into his locality 50 colonies, and almost immediately every one of them became badly affected. By killing off the queens and introducing his own stock he cured the disease.

Repeated tests have shown that paralysis is never transmitted by the brood or combs, but that it is carried by the dead or sick bees. It is important, in giving the

combs to the nuclei, that there be no dead bees in the cells.

The Disappearing Disease (*Nosema apis*)

This is a malady very similar to the Isle of Wight disease. It has been found in numerous apiaries of the United States. At one time it was believed that this might be Isle of Wight disease; but the evidence shows that it is something else. There are two distinguishing symptoms that would seem to put the disappearing disease in a class by itself. As already pointed out, it disappears in from ten days to two weeks. This is something that never occurs with the Isle of Wight disease, the ravages of which continue indefinitely until the colony succumbs. Another marked symptom not found in the Isle of Wight disease is the fact that sick bees with disjointed wings in front of the entrance run like crickets, or as if in great distress. They keep up this mad rush until exhausted. From this time on the symptoms are similar to those observed in the Isle of Wight disease. Bees never run when afflicted with bee paralysis.

In 1915 (which was unusually wet) there was a scourge of disappearing disease in this country, particularly around Portland, Oregon. In the disease reported from the Northwest, it was stated that the brood itself was sometimes involved. But if there were a large loss of bees it is apparent that the brood would be neglected, and therefore die of starvation.

A condition similar in many respects was noticed down in the Mississippi Valley, in parts of Texas, California, and in some of the West Indies in 1915; but as soon as settled warm, dry weather came on it disappeared.

Again in 1917 there was an outbreak in the United States. The author examined a number of apiaries where these attacks occurred. In a few cases whole colonies were depleted of bees. In other cases the owners of the apiaries reported that if the decimation continued there would not be a bee left in any hive; but fortunately the disease, whatever it was, after reaching a certain height will suddenly disappear, and hence it was called the "disappearing disease." The name seems to be appropriate because the bees disappear as the disease itself disappears or the colonies dwindle. During the last few years this disease has in many places materially cut down the honey crop and in some cases has wiped out entire apiaries. In 1919 Herman Ahlers, of Oregon, reported a loss of 400 colonies from this cause.

While the author was in California in 1919 an outbreak of the disappearing disease was observed in certain parts of Ventura County during the spring of that year. He was asked to investigate and give his opinion. An investigation showed a typical case of the disappearing disease. In ten days' time all active symptoms of the malady had disappeared, and the colonies assumed their normal condition without any treatment whatever. But as the disease or malady developed right in the midst of a honey flow the crop was lost.

No Cure

There is no cure for disappearing, or *Nosema* disease. The affected bees, as explained, rush away from the hive and die. As soon as all the sick and dying are out of the hive the colony recovers and probably the following year there will be no recurrence. Why *Nosema* is present and destructive some seasons and not others is not known.

Differential Diagnosis

Bee paralysis differs from disappearing disease (*Nosema apis*) mainly in the following respects:

1. In bee paralysis the bees in practically all cases are shiny black; bodies distended or badly swollen; bees are listless; wings tremble; movements slow; may be found in and out of the hive.

2. In disappearing disease the bees appear to be normal; they are not discolored; bodies are not usually swollen or distended, but wings are out of joint in some cases. The movement is quick or rapid, like the running of a cricket. This rapid movement, always away from the hive, continues until the bee is exhausted and then it slows down until its movements cease altogether. In some cases it tugs at its body as if in pain, but it keeps on moving until it is unable to go any further and then dies.

3. In bee paralysis the dead and dying seem to be confined to some in the hive and within an area extending three or four feet from the entrance of the hive. In disappearing disease the bees may be found all over the bee-yard and sometimes from a quarter to a half mile away from the apiary. When the whole bee-yard is affected it will be almost impossible to

go through the apiary or near it without stepping on bees. The writer has seen that condition in several places in the country, especially in California. On the sidewalks and on the public highways will be found dead and running bees. Sometimes they are as close as a foot apart. When the bees are scattered all around in the locality for about half a mile the whole apiary is involved.

4. The outward symptoms of disappearing disease are manifested for only a short time, seldom lasting more than a week or ten days. The bees disappear and the disease likewise disappears, hence the name. After the runners are all out, the colony (what is left of it) will recover. In bee paralysis the disease does not disappear. It lingers all summer until the colony finally dies, unless remedial measures are applied. The same thing is true of the Isle of Wight disease.

5. So far as the writer knows, the protozoan *Nosema apis* has not been found in bees affected with bee paralysis, but this protozoan is usually found in all cases of disappearing disease.

6. Disappearing disease comes on generally before or at the beginning of the honey flow. Apparently the bees have been previously infected with the protozoan, but as soon as a sudden strain of gathering honey comes upon them they die off in large numbers. When all the infected bees are dead and in the field or on the ground the young bees in the hive not affected take care of the emerging brood, and in the course of a month or six weeks the colony will recover, but the honey crop has been lost.

7. In bee paralysis the affected members will appear on top of the combs as soon as the cover is lifted. Bees will be black and wings trembling. In disappearing disease, the sick bees are all outside and running like mad, some with disjointed wings.

8. Disappearing disease is much worse some years than others. A period of several years may elapse during which we hear little or nothing of it. Then suddenly it breaks out here and there. This is also true of bee paralysis.

9. Disappearing disease will often be found in one or two colonies of a yard. It goes no further and in the meantime the colony recovers. It is very seldom that a whole apiary is involved. Bee paralysis is seldom found in more than one or two colonies.

Isle of Wight Disease, or Acarapis; Also Called Acarine Disease

This is a disease that was first found in the Isle of Wight, south of Great Britain, in 1904. It continued from year to year until it came very near wiping out all the bees on the island. It was feared that it might get on the mainland of England, and in 1907 it did make a start there. At first but little attention was paid to it; but the beekeepers of the British Isles learned that it was something very serious—much more so than European or American foulbrood.

A careful reading of the reports in the *British Bee Journal*, covering a period of ten years, indicates the symptoms of Isle of Wight disease are as follows:

A few bees will be crawling out of the hives the same as when attacked by bee paralysis, crawling up spears of grass. If they can fly at all, it is but a few feet. In a few cases the abdomens are distended by fecal accumulations. In most cases there is no distention. Sometimes the smaller or the larger wings in some specimens seem to be out of joint. In bee paralysis the wings appear normal, but show a tremulous motion; but very little of this tremulous condition has been seen in the Isle of Wight disease. The bees sometimes lose the use of one or more pair or legs, or drag their hind legs, though the others may be more or less vigorous. The bees become listless, and cluster in bunches around the entrance of the hive. In bee paralysis there may be somewhat similar clustering, but the bees are more scattered. The affected bees of the Isle of Wight disease, from reports, are rarely black and shiny as in bee paralysis. In fact, in many cases they seem to be quite normal in their appearance, differing only in their behavior. As the disease advances, the crawling bees will drag their abdomens on the ground, seeming not to have the power to carry them as they ordinarily do, owing to their inability to take the cleansing flight. As it progresses further, every bee in the hive will be involved, and finally the cluster will be reduced to just a very few in the hive centering around the queen. The queen seems to be the last one affected.

The intestines of some of the infected

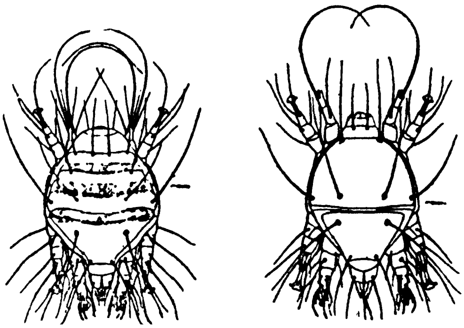
bees are said by some writers to contain a large amount of undigested pollen. When this disease is contracted, the bees seem to have an unusual fondness for nitrogenous food, even gorging themselves with pollen of all kinds without collecting any in their pollen-baskets. This is doubtless what causes the abdomens of some of the bees to be swollen. So distended at times are they that it appears to interfere with the proper action of the breathing spiracles.

Sometimes, more especially in early spring, the affected bees seem to lose control of the muscles of the bowel and discharge a liquid looking very much like that of ordinary dysentery.

Cause of Isle of Wight Disease

For many years the cause of this disease was unknown. In 1912 and 1913 it was believed that it was due to a protozoan, *Nosema apis;* and this view was held until 1920, when Drs. Rennie and White, and Elsie J. Harvey, of Great Britain (particularly the last named), discovered that the primary cause is not a protozoan or a bacterium, but a parasite or a mite, *Tarsonemus woodi.* This parasite, according to their paper, published in the Transactions of the Royal Society of Edinburgh, Vol. LII, Part 4, attacks the bees through the breathing orifices. To quote exactly, it "occupies a very restricted region in that part of the tracheal system which has its origin at the anterior thoracic spiracle. In a well-established case of infection it will be found that, extending inward from this spiracle on either side indifferently, parasites in all stages of development may be present in any part of this portion of the respiratory system, while the ill effects of their presence may be seen not only in the region of occupation but in the muscular tissue to which these extend. It is not an infrequent occurrence in advanced cases of the disease for these wider tracheae to be occupied by mites in closely packed formation. All stages of development occur: e. g., ova, larvae, nymphs, and adults may be found together. In the smaller branches, frequently these are occupied as far as their diameter will permit, when a single individual may be found practically blocking the tube, and sometimes a linear succession of individuals may be seen in such a position. * * * The primary parasitic invasion takes place through one or both of the first pair of spiracular orifices, and apparently through these alone." The infection may be on one or both sides. Quoting again: "A single mite may enter the bee, or several may enter together or at intervals. * * * It is usually only during the latter stages of attack that the mite attains the smaller tracheae, the thoracic air-sac, and the vessels of the head."

In later work by Stanley Hirst, the English specialist in mites, it would appear that the mite in question is so specialized in structure that it should be placed in a new genus. It should, therefore, according to this authority, be called *Acarapis*



Mite associated with Isle of Wight disease. Figure at left male, dorsal view. Figure at right, female, dorsal view.—(Hirst.)

woodi. Acarapis comes from two Latin words, *Acarinus,* mite, and *Apis,* bee. This would appear to be an accurate designation, and scientists now generally accept the findings of Hirst.

The illustrations above will give some idea of the parasite, so that should it ever be found in the United States, other investigators will be able to identify it. For a full account of Hirst's findings, see the Annals and Magazine of Natural History for June, 1921, Volume VII, No. 42 (9th series), pages 509-519.

Distribution of the Isle of Wight Disease

The ravages of this disease seem to be confined mainly to the British Isles, and it is here that it has wrought such awful havoc among the bees and beekeepers. From recent investigations by Phillips it appears that the disease is not as serious as it was a few years ago. This is doubtless due to the fact that, since its cause is definitely known, remedial measures may be more intelligently applied.

The disease has been definitely located in parts of France and Switzerland. In 1928 it had not been found in Italy, Carniola, or Germany. It is believed, how-

ever, that later investigators will find it in those countries.

No Isle of Wight Disease in the United States

In 1922 the Bureau of Entomology, Washington, D. C., invited the beekeepers of the country to send to the laboratory any adult bees which showed any abnormality whatever, and as a result 183 specimens were received for examination. These specimens came from 35 different states, including provinces of Canada. Most of the examinations were negative, and in no case showed anything worse than *Nosema apis*. The Bureau likewise examined specimens of bees and queens from Carniola and from Italy, but no mites of *Acarapis woodi* were found. Specimens from Canada were examined with like results.

Most of the importations of Italian queens come from Italy and Carniola. The fact that no Acarine disease has been found in these countries is probably the reason why that disease has not found its way into the United States. But the fact that *Acarapis woodi* has been found in so many countries of Europe would rather lead one to believe that it may make its way into the countries just mentioned.

Embargo on Importations of Queen Bees from Foreign Countries into the United States

In view of the fact that no Isle of Wight disease was found in the United States, but that it had been located in several countries of Europe, especially in Great Britain, a law was passed by Congress in 1922 placing an embargo upon all shipments of adult bees from foreign countries, but provided "that such adult honeybees may be imported into the United States for experimental or scientific purposes by the United States Department of Agriculture; and, provided, further, that such adult honeybees may be imported into the United States from countries in which the Secretary of Agriculture shall determine that no disease dangerous to adult honeybees exists, under rules and regulations prescribed by the Secretary of the Treasury and the Secretary of Agriculture."

The ruling has been made that bees may be sent from Canada to the United States without passing through the Department. From all other countries, however, bees and queens must first go to the Department, there to be examined by the experts, and if no Acarine or Isle of Wight disease is found, the bees may then be forwarded to the original purchaser. Many importations have been made, and so far the law has worked no hardship on anyone and yet has protected the industry as a whole from the terrible ravages of Isle of Wight disease.

For further particulars on the Isle of Wight disease the reader is referred to two valuable papers by Doctor E. F. Phillips, then in charge of apicultural work at the Bureau of Entomology. The first was issued in March, 1922, from the Department as Circular 218, and the second in November, 1923, as Circular 287.

Cure for Isle of Wight Disease

It has been found that this disease affects mainly the old or field bees. In the absence of any evidence to the contrary, it may be inferred that flying bees may, by mistake, go into a neighboring colony carrying the parasite from colony to colony. As in the case of American foulbrood, it would be natural to expect that all colonies near the one affected with Isle of Wight disease will sooner or later get the mite.

As a cure, several different plans have been suggested. One is to destroy all flying bees and then put all the brood into a healthy colony or in an incubator where it can emerge. Another plan is to catch the incoming bees in a trap until all flying bees are caught. On the theory that the young bees do not have the mite, the colony would rapidly recover.

So far no form of gas has been discovered that would kill the mites and not kill the bees themselves. It would seem to be a case where prevention is infinitely better than cure. The various governments have been wise, therefore, in passing laws to prevent the importation of the mite.

DISTANCES BEES FLY.—See Flight of Bees.

DIVIDING.—Under the heads of Artificial Swarming, Increase, Nucleus, and Swarming, are shown various methods of dividing. But dividing, as it is ordinarily understood, has to do with the operation of increasing the number of colonies by taking a part of the frames and adhering bees, with or without a queen, and putting them in another hive on another stand. For a beginner, dividing is

often unscientific and wasteful, while artificial swarming or division on the plans described under Nucleus and Increase are scientific and profitable, because they are worked in such a way as to secure a honey crop as well as an increase in the number of bees or colonies. Dividing may be performed so as to ruin all chances of a honey crop, and in addition leave the apiary with a lot of weak nuclei in a totally unfit condition to go into winter quarters. It is an axiom in beekeeping that one good, strong colony will secure more honey than that same colony unintelligently split into halves and put on two different stands; but with an expert beekeeper dividing can often be practiced to advantage, especially in some localities.

Profitable Dividing

Dividing well-wintered colonies in the spring in localities having a relatively late main honey flow, such as in the sweet clover region, and some localities in the South, may often be practiced to advantage. In such localities many beekeepers are now making a practice of splitting their colonies into two parts, dividing bees, brood, and honey as nearly equally as possible, then giving the queenless portion a young laying queen. In order to prevent the field bees from returning to the old location, one of the divisions is moved at once to another apiary. When such a division is made six or eight weeks previous to the beginning of the main honey flow, the result, if all goes well, is two colonies each in better condition for the honey flow than the original colony would have been if left undivided. This plan requires good wintering, together with a long building-up period in the spring, or, in other words, a relatively late honey flow. If increase is not desired, the colonies can be arranged in pairs so that they can easily be united in the fall, thus making rousing colonies for the winter. This method of beekeeping is no longer in the experimental stage in the sweet clover region, but is being successfully applied on a large scale by many.

In localities where the main honey flow comes relatively early, thus making a short building-up period in the spring, such as the orange region of southern California, many localities in the South, and the white clover and alsike clover region of the northeastern portion of the United States and eastern Canada, beekeepers usually think they are doing well if undivided colonies are able to build up to full strength in time for the main honey flow. However, it is possible to use this method profitably even in these localities. As an experiment along this line a number of colonies were divided about the middle of April in the author's experimental apiaries. Since there was no sweet clover in the locality the honey flow closed early when the alsike clover was cut for hay. Yet each division of the colonies that were divided in April gave practically as much surplus honey as did the undivided colonies. To put it another way, the yield was increased 100 per cent by this dividing.

Dividing colonies previous to the main honey flow in such localities is so unorthodox that the author hesitates to mention it; but better methods of management during late summer and fall, together with better wintering, now make it possible to practice this method even in the white clover and alsike clover region. Of course, it would be folly to divide weak or poorly-wintered colonies in this way, and good judgment must be used in the procedure. By reuniting two colonies strong in young bees in the fall, when increase is not desired, the way for a spring division is well prepared. The rapidly increasing acreage of sweet clover in the white clover and alsike clover region is so prolonging the main honey flow in many localities that this method may soon come into general use in this region. (See Building Up Colonies and Food Chamber.)

DOMESTIC ECONOMY OF THE HIVE.—See Bee Behavior, Brood and Brood-rearing.

DRIFTING.—This is a word that has been coined by beekeepers to designate bees in the air that by mistake go into the wrong hive. Young bees in their playflights (referred to under Playflights of Young Bees and under Robbing), not having thoroughly learned the location of their homes, will drift to a hive or hives where bees are flying strongest, and go in just as if it were their own home. Even the old bees, when all the hives are set out of the cellar, will very frequently drift into the wrong hive. The colonies that are making the biggest hubbub in front of the entrance will attract flying bees from their weaker neighbors.

Drifting also takes place when a large number of similar hives are placed in one row. When the conditions at each entrance are practically the same, the bees become more or less confused. If there is any disease in any hive, drifting will carry it to the neighboring hives. Under the head of Apiary is emphasized the importance of so placing the hives in a yard that each colony of bees can recognize its own entrance. The hives should face different points of the compass, except toward the north, and stand near some distinguishing object. Shrubs or bushes of different sizes, a tree, a stump here and a building there, all serve the purpose of giving each hive a location and an identity all its own.

When the hives are placed in pairs there is not much danger of the bees of the weaker colony drifting into the stronger one, for the bees seem to know the difference between right and left in going back home; but they do not readily distinguish their own individual entrance when the hives are painted the same color, and when each hive looks exactly like other hives in the row.

Many of those using the quadruple winter packing-case, having two entrances on the side, report considerable drifting and great variation in the size of colonies in the spring. This can be corrected by nailing a board three or four inches wide between the two entrances.

Drifting when taking bees out of the cellar can be avoided somewhat if the directions under Wintering in Cellars, subhead Time of Day to Take Bees Out, are followed. Drifting can be avoided when locating bees at outyards by moving them toward night, and placing them on their stands when it is too late for them to fly, being careful to place the hives so that each colony will easily distinguish its own hive. Next morning they will mark their entrances.

Why Are Not Drifting Bees Stung Like Robbers?

The novice will, perhaps, ask the question why, when bees drift into the wrong hive, they are not instantly killed by the guards at the entrance, the same as happens in a case of robbing. When bees drift, as already explained, it is because a new condition has been created, or because the young bees when at play have not yet thoroughly learned their location. When they go by mistake into the hive, they enter as though it were their own hive. Robber bees (see Robbing) show by their nervous actions that they are afraid of being grabbed by the guards of the hive they propose invading. Their nervous actions, seeking by stealth or quick dodging to get into the hive, betray them at once. On the other hand, the drifting bees show no such behavior, and, of course, go directly into the hive as if they belonged there.

In the case of bees just out of the cellar, many, rushing out into the air, scarcely know whence they came, and the result is they will return to the entrance of the strongest flyers, or where the greatest demonstration is being made, and so go in without arousing suspicion.

When bees are out for a playflight there will be a big hubbub in front of the hive whence they came. Other young bees in the air, or in near-by hives, attracted by their antics in the air, are quite inclined to join in the fun, for fun it evidently is. When the frolic is over, nothing can be more natural than for the whole bunch of them to go into the hive whether they belong there or not. If the hives are properly located, there will be very little drifting as a result of playflights.

DRONES.—These are the male bees of the colony. They are large noisy fellows that do a great amount of buzzing, but never sting anybody, for the very good reason that they have no sting. The beekeeper who has learned to recognize them, both by sight and sound, never pays any attention to their noise, but visitors are many times frightened by their loud buzzing.

If the colonies are prosperous, one may find eggs in the drone comb of some of the best hives as early as March in the North, but not, as a general thing, until April. In the southern states drones may or may not be found in the hives every month in the year. The drone-cells can be told from the worker at a glance by the size. (See Honeycomb; also Brood and Brood-rearing, large cut.) Whenever eggs are seen in the large cells, it may be assumed they are drone eggs. It is not meant by this that the eggs that produce drones look any different from any other eggs that the queen lays, for in appearance they are precisely the same.

They are the same in every respect, except that the eggs that produce the worker bees have been impregnated, while the others have not; but more of this anon. The egg, like those producing workers, remains brooded over by the bees until it is about three days old, and then by one of nature's wonderful transformations it is gone, and a tiny worm appears, a mere speck in the bottom of the cell. This worm is fed as before, until it is about a week old, and is then sealed over like a worker larva, except that the cap to the cell is raised considerably more; in fact, the cappings very much resemble a lot of bullets laid closely together on a board. (See Brood and Brood-rearing.) The young drones will begin to cut the caps of these cells in about 24 or 25 days; the caps come off in a round piece, very much like those from a queen-cell.

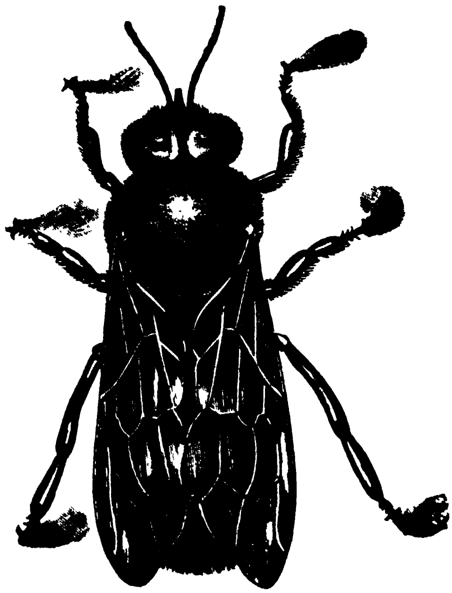
The body of a drone is hardly as long as that of a queen, but it is so much thicker through than that of either queen or worker that no one will ever mistake him for either. His two compound eyes are much fuller, his head is much thicker, and his wings larger. He has no baskets on his legs in which to carry pollen, and his tongue is so unsuited to the gathering of honey from flowers that he might starve to death in the midst of a clover field in full bloom.

The Mating of Queen and Drone

The young drones are ready to leave their hive after they are about two weeks old*, and they do this shortly after noon of a warm pleasant day. They come out with the young bees as they play and first try their wings; but their motions are far from being graceful and easy, and they frequently tumble about so awkwardly that, as they strike against one's face, he might almost think them either drunk or crazy.

Some facts seem to indicate that drones, as well as the queen, may fly long distances from the hive — perhaps two miles or more. The meeting between queens and drones takes place not very high up from the ground. Several observers have reported seeing this meeting not far from the hives, during tne swarming season. The queens and drones sally forth during the middle of the day, or afternoon, and in from 15 minutes to an hour, or possibly two hours, the queen returns with a white appendage attached to the extremity of her body, which microscopic examination shows to be the generative organs of the drone. If one takes a drone in his hand some warm afternoon just as the drone has sallied from the hive, and presses him in a certain way, he will burst open, something like the popping of a grain of corn, extruding the same organ that is found attached to the queen, and dying instantly.

When the young queen goes forth to mate she will hunt a school of drones, which she easily finds by their loud humming. From one to twenty or more will immediately take after her. The successful one will make a couple of circles about her, finally grasping her, face to face. They may both fly away a short distance, embraced in a nearly vertical position. Both may drop to the ground at once, or come down later. The queen then tries to free herself, while the drone



Drone bee enlarged four times.

*AGE OF SEXUAL MATURITY OF DRONES

By a histological and anatomical study of the drone organs and their secretions, as well as by other means. Bishop (Bishop, Geo. H., 1920, Fertilization in the Honeybee) found that the drone is not sexually mature at the time of emergence, but undergoes a further growth period of at least nine to twelve days. During this period many changes take place in the drone organs, especially up to the sixth day, after which the changes are slight.

F. W. L. Sladen, Apiarist of the Canadian Department of Agriculture, conducted some experiments by carrying virgin queens and young drones to an island for mating. He reports that queens mated to drones under two weeks of age produce a large percentage of infertile eggs, thus confirming in a practical way the findings of Bishop.

Drones at the close of the honey flow turned out to die.

clings to anything he can get hold of. She finally jerks loose, carrying away the drone organs, while her mate crumples up and dies. Thus he has his wedding flight and his funeral at one and the same time.

A few have reported that the separation between drone and queen after copulation takes place in the air; but the bulk of the evidence seems to support the view that they both drop to the ground, when the queen pulls herself loose.

The queen, after mating, goes to her hive, absorbing the spermatic fluid. Shortly after, the bees pull away the drone organ, emptied of its contents. While it is generally believed that this one mating suffices for the rest of her life, several authentic instances have been given, tending to show that an occasional queen may mate the second time. This is quite possible, although somewhat difficult to prove. See articles on pages 443 and 720 of Gleanings for 1927.

Does the Drone Have Only One Parent?

One of the most wonderful things about the drone, or male bee, is that it is hatched from an egg that is unimpregnated. So wonderful, indeed, is this that the matter was for years disputed. By unimpregnated is meant that queens that have never met the male bee will lay eggs, and these eggs will hatch, but they always produce drones, and never workers.

Does the drone grow out of nothing, without parentage, at least on the paternal side? If his mother was an Italian, he is also an Italian; if a black queen, he is also a black. It is necessary to conclude, perhaps that he is the son of his mother, and nothing more. The egg that has never been impregnated in the usual way must, after all, have some living germ incorporated in its make-up, and this germ must come only from the mother.

The reader will therefore see that drones are in no way affected by the fertilization of the queen; or, in other words, that all daughters of a purely fertilized Italian queen produce drones absolutely pure whether she has been fertilized by a black drone or not. (See Dzierzon's Theory and Parthenogenesis.)

Drones from Worker Bees

Drones are also hatched from eggs laid by worker bees. These drones are usually smaller in size than those from a queen, because they are generally reared in worker-cells. The question as to whether they are capable of fertilizing queens, so as to be of some value, like other drones, is one that has never been decided. Some facts have been brought to light that seem to offer good evidence on each side of the question; but so far there is nothing very definite.

Drones from Drone-layers

Queen-breeders find that one or more drone-layers of good stock, rearing fully developed drones, if supplied with plenty of worker brood, will furnish a fine lot of nice drones in and out of season; but drones from laying workers, or from queens that have never been fertilized, probably should be avoided. Drones from queens that have once laid worker eggs, and then failed, are as good as the drones from any queen.

Cost of Rearing Many Drones

Until the invention and general adoption of foundation there was no easy way of repressing the production of drones in far greater numbers than could ever be desirable. (See Comb Foundation.) Since the introduction of that article it is found to be quite an easy matter to make almost every cell in the hive a worker-cell. On the other hand, one can have a hive entirely filled with drone comb, and a good queen could be induced to raise nearly, if not quite, a full quart of drones at a time. By this means one can have his drones raised from such stock as he chooses, and he can save the vast amount of honey that has so long been wasted by rearing an unnecessary number of drones.

This general subject is covered under Combs and in a more technical article called parthenogenesis elsewhere in this book, and also under head of Queens.

Rearing Drones Out of Season

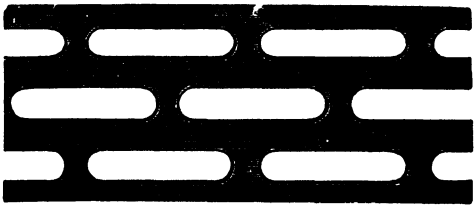
When the honey flow is drawing to a close, and the bees may be expected to begin disposing of their drones, take frames containing drone brood from the colonies having the best queens to breed from, and place them in a strong colony. The colony should be made and kept queenless, should be given one pint or more of syrup (two parts of water to one of sugar) every day as long as drones are needed. The feeding must be kept up, for bees are very easily discouraged; and if a stoppage occurs in the daily supplies they will not hesitate to pull the young drones out of their cells and sacrifice them without mercy.

Destruction of Drones in the Fall

This does not necessarily occur in the fall, but may take place at any time in the summer, just after the honey flow. Drones have been killed off between apple bloom and white clover, only because supplies ceased, causing the bees to become discouraged and give up swarming for the time being.

How to Tell When the Honey Season is Growing

There is no way in which one can tell so well that the yield of honey has ceased as by the behavior of the bees toward their drones. When, in the midst of the honey season, a worker is seen buzzing along on the back of a drone that seems to be doing his best to get away from the hive, it may be concluded that the yield of honey is failing. So far as known, bees do not sting drones, but they sometimes pretend to do so. It is probable that it is only a feint to drive them away. The poor drone at such times, after vainly trying to go back into the hive, will sometimes take wing and soar away off in the air,

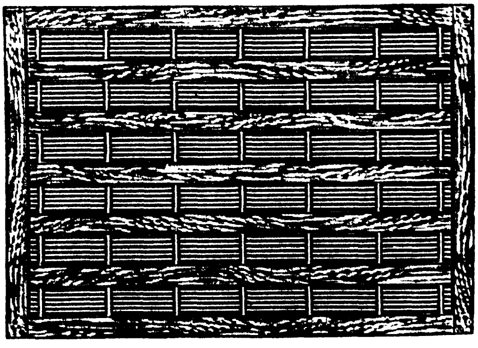


Perforated zinc.

only to return after a time to be repulsed again, until, perhaps, through weakness and want of food, he flutters hopelessly in the dust, and so submits to the fate that seems to be a part of the inexorable law of nature and of his being.

Drones with Heads of Different Colors

This is a queer feature in natural history. Almost every summer some one writes or sends specimens of drones with heads of different colors. The matter has been reported and commented on at different times in Gleanings in Bee Culture. Not only are drones with white heads occasionally found, but also with heads of a cherry color; again, of a bright green, and at other times yellow. Why should this peculiarity show itself in the drones more than in the queens and workers? Again,



Wood and wire honey-board.

why should *heads* be the subject of these bright rainbow colors? (See Hermaphrodite Bees.)

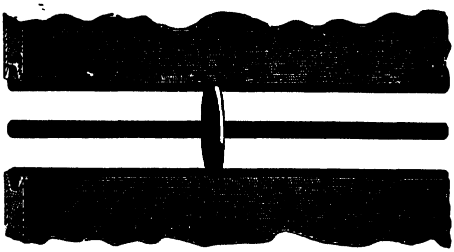
Restraining Undesirable Drones

Drones undesirable for breeding purposes may be prevented from going out to meet the queens by keeping them from go-

ing out of the hive, or by letting them go out into a cage through which workers can pass and they can not. This is done by taking advantage of the fact that a worker bee will pass readily through slots in perforated metal (or between bars properly spaced) where a drone can not.

The Proper Size for the Perforations

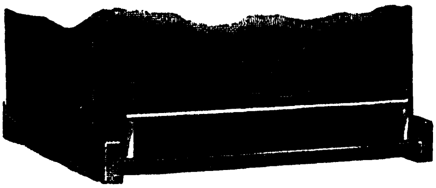
The oblong holes must be of such a size as to permit the easy passage of workers, but exclude not only drones but even queens (see Extracted Honey and Swarming). It is no great task to make



Full-sized wire-excluder.

the perforations drone-excluding; but to make them *queen-excluding* at the same time, and yet not hinder the easy passage of workers, requires a very nice adjustment in the width of the perforations. Experience shows this to be .163 of an inch.

In 1908 there was put on the market a new form of queen-excluder consisting of wire bars held at the required distances apart by means of soft-metal cross-ties at every two or three inches. These bars consist of No. 14 hard-drawn galvanized wire that has been straightened in a wire-straightener so that it is as true as a die. Contrary to what one might expect, the spaces between these bars are more exact



Wire entrance-guard.

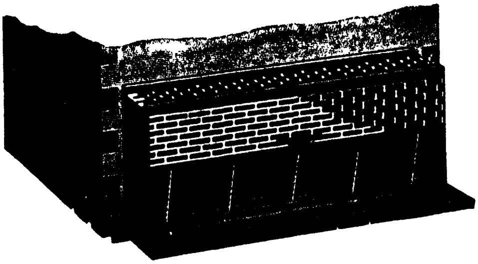
than the width of the various perforations in sheet metal. In the process of making, the bars are laid in metal forms having grooves that are spaced exactly right, and then a soft metal in a molten state is made to flow in certain cross-grooves of the metal form. As the metal cools almost instantly, the wires are held at exactly the right intervals. The smooth rounding edges of the bars afford less obstruction to the bees passing and repassing, and practical tests show that this form of excluder is much superior to the old perforated metal. On account of the rounding smooth edges of the wires, they must be slightly closer, or .162 of an inch.

In the manufacture of the perforated zinc, unless the dies are very sharp, there will be a slight rough burr edge on the under side of the sheet. It is impossible to remove this edge without reducing the width of the perforation. For this reason the wire excluder is superseding the perforated zinc.

Drone-excluding Entrance-guards

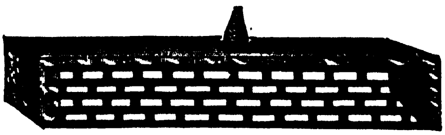
If a strip of perforated zinc or wire excluder is placed over the entrance, the worker bees can go out, but the drones can not.

When it is desirable to get the drones all out of a hive without permitting any to get back again, the guard is put over the entrance and all the bees are shaken in front of the hive. The workers will, of course, crawl back on the combs; but the drones will have to stay out, and the queen* too, unless she is put in the hive. In the morning, when the drones are stiffened with cold, they may be fed to the chickens or otherwise destroyed.



Wire and zinc Alley trap.

The drone-excluder just described is not automatic. Accordingly, Henry Alley devised the ones shown above and below.



Alley's drone-excluder.

This is similar to the one just described, only it has a wire-cloth cone in the top. The drones, after making a fruitless

*This method is sometimes used to catch the queen in a colony of black bees.

attempt to pass the metal, will enter the wire-cloth cone in the top, and escape; however, none will go back the way they came, but will huddle together outside and await their fate.

If it is desirable to get the drones into a box, so they may be carried to some other apiary, for instance, a cage is made with an upper story, and a couple of these wire cones conduct the drones "upstairs." If any worker bees should go up too, they can readily go up through the excluder. This latter arrangement is shown in the cut above.

DYSENTERY.—This is really a form of diarrhea that afflicts bees. It is not a disease as would be the case in real dysentery, but a functional disorder due to too long retention of the feces during winter, caused by bad food or improper protection, or both. The term "dysentery" is here retained, not because it is accurate, but because it has been used so generally in bee literature.

Symptoms

The fecal discharge is thin and watery, ill-smelling, and from a light yellow to a dark brown. In advanced cases the color is almost black. The abdomens of the bees are swollen considerably, and sometimes are almost twice the normal size. The bees have a dark, greasy-looking appearance, and act listless. Individual bees will be seen crawling out of the entrance, and the front of the hive will be stained with yellow, brownish, or nearly black splotches. Ordinary dysentery, when destructive, is a malady that appears only during winter or early in the spring.

At any time of the year, however, when the weather has been cold or rainy for several days, normal bees as soon as they can fly will void on the hives, walks, and ground yellow-brown spots or dark spots or dark strings of excrement in a more solid form. Bees that have been confined in the cellar all winter and have wintered well will, when set out, void their feces in a more or less liquid form over everything. These spots do not signify that anything is wrong. (See Bees as a Nuisance.) Some of the colonies at this time in the spring may have real dysentery; but probably the majority of them, if they wintered well, will be in a perfectly normal condition. The presence of these spots on the hives during summer is not a bad omen, because active bees, when shut in the hives after flying for several days, always throw out some discharge when they fly.

In an advanced form of dysentery—the kind that destroys bees or colonies—the outside of the hives will be badly smeared up with dark-brown (almost black) stains. These stains, when the trouble has progressed to a point where most of the bees are dead, will be smeared all over the combs and the inside of the hive; and when the colony reaches that stage no amount of good weather will help it. The queen, however, will be all right, and may be introduced into any colony. The bees remove the feces from the queen as fast as necessary, so that she never suffers as do her subjects from an impacted bowel tract that causes dysentery.

Causes of Dysentery

The real causes are bad food and long-continued low temperature that prevents bees from flying. In order to keep up sufficient animal heat the bees have to overeat, surcharging their intestines. The long-retained fecal matter results in purging or dysentery. Any food alone would hardly produce the disease, as one rarely, if ever, finds bees suffering from anything they will gather, in warm summer weather. Unripe aster honey (see Aster) or the sweet juices from rotten fruit or cider are very productive of this complaint, and are almost sure to kill bees at the approach of cold weather. They all died of dysentery long before spring. Sorghum syrup has brought on a very aggravated form, and burnt candy or sugar is almost sure death to bees during cold weather, although such feed may be given with impunity in the middle of the summer. (See Candy.)

All candy or honey containing gums or dextrins should also be avoided; for, except in a few rare instances in which another substance is involved, these gums or dextrins are substances that cause dysentery. The dextrin content of the different honeys varies considerably, being greatly reduced during a rapid honey flow.

On account of the dextrin content, New Orleans molasses and common glucose should not be given to bees. As a matter of fact, they will not take either.

A colony well packed, as shown under Wintering Outdoors, will stand an amount

of bad food without dysentery much better than a colony in a single-walled hive.

The Agency of the Aphids in Producing Dysentery

The poorest winter food is, without doubt, the honey gathered from the aphids (see Honydew); at least, most complaints have been made of this honey. As bees seldom touch this, except during drouths or unfavorable seasons, it, no doubt, has been the cause of some of the mischief. If all the early honey is extracted from the brood-combs, and the bees left with nothing but this bad honey, gathered in the summer, the matter is much worse; and many cases have been reported of colonies dying where the extractor has been used, while those untouched had been free from the disease. The obvious remedy is to refrain from extracting at all from the brood apartment. Let the bees fill their brood-chamber with a good quality of honey, just before the yield ceases, extracting, toward the close of the harvest, only from the combs in the upper story, unless it is decided to hold such honey for winter. (See Food Chamber.) There have been some favorable reports of wintering on honeydew, from which it may be concluded that it is not always deleterious.

Pollen Not the Cause of Dysentery

Along in the early eighties and almost up to recent times it was believed that an excess of pollen in the combs or in the honey was an important cause of dysentery. There was put out what was called the "pollen theory." Pollen, it was said, caused bad wintering and that, therefore, only sugar syrup should be given to bees for a winter food in place of honey, because honey contained pollen. We now know that there is no better food than good honey in a food chamber and pollen in the combs and in the honey itself. Without the pollen, brood rearing can not proceed satisfactorily in the spring to replace the loss from the constantly dying off of the old bees.

Prof. H. F. Wilson and C. W. Roe of the University of Wisconsin, Madison, Wisconsin, proved conclusively that pollen was not one of the causes for spring dwindling or dysentery. (See Gleanings in Bee Culture, page 704, 1929.) As their conclusions are so nearly in accord with what has just been said they are reproduced here.

Conclusions

1. Pollen used in these experiments does not appear to be in any way responsible for causing dysentery of bees.
2. There seems to be no difference between filtered and unfiltered honey in the development of dysentery among bees.
3. Hawaiian honey has the materials which causes dysentery among bees.
4. Tulip honey also seems to contain some of the materials which cause dysentery among bees, but not to the extent of Hawaiian honey.
5. Porto Rican honey also seems to contain similar materials which cause dysentery.
6. Tupelo honey from J. J. Wilder's apiary near Waco, Georgia, did not show signs of containing materials that cause dysentery.
7. The clover honey from Wisconsin used in these experiments did not appear to contain materials which cause dysentery.
8. Dandelion honey from Colorado did not appear to contain materials which cause dysentery
9. Pollen added to sugar syrup did not cause dysentery even in amounts sixty times greater than in normal honey.
10. Commercial starch and dextrine added to sugar syrup did not cause dysentery when used for winter stores for bees.

Prevention of Dysentery

There are two important factors in the prevention of dysentery — protection against extremes of cold during winter, and good food. Under the head of Wintering Outdoors, Wintering in Cellars, Spring Dwindling, and Spring Management, full particulars are given on how to house bees properly. Under Food Chamber it is told how to have strong colonies.

Good food may be in the form of good honey well ripened or sugar-syrup stores. Any of the good table honeys make suitable food, and many of the fall honeys do very well. Aster honey, unless well ripened and sealed in the combs, sometimes brings on dysentery. Some winters it is worse than others (see Asters). Honeydew usually should not be used. It is generally dangerous. (See Honeydew.)

Cure for Dysentery Outdoors

If the affected colonies are outdoors, about the only real remedy is settled warm weather. Even one good warm day will often serve to alleviate the trouble, as it gives the bees a chance to void their excrement out in the open air, away from the hives and the combs. Otherwise the continued confinement during an extended cold spell sometimes compels the bees to retain their feces so long that they are finally forced to void it over the combs and over the hives.

Package Bees to Cure Dysentery

As one of the primal causes of dysentery is weakness or lack of sufficient strength to the colony, the deficiency can be corrected by giving it a package of two or three pounds of young, vigorous

bees just from the South. If there is sufficient protection and good stores this fresh infusion of new life will clean up the combs and save the bees that are left. As a rule, a very weak nucleus, unless the queen is valuable, is hardly worth saving. It can, of course, be united with one or more other nuclei, but it will do little good. The several bunches of bees will return to their old stand if from the same apiary. (See Spring Dwindling.)

Combs taken out of the hive in cold weather, and stained with dysentery, may be given to strong colonies in late spring or summer to clean up. There is no danger in hiving swarms in hives where colonies have died with dysentery during the previous winter. They will quickly clean up and use the stores that are left.

Dysentery in Bee-Cellars

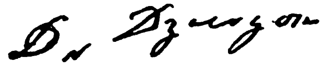
After a long and cold winter if the temperature in the cellar goes much below 40° F., or if the stores are of poor quality, there is a liability of some colonies being affected with dysentery. The best remedy is prevention. The cellar should be dry, and the temperature should be between 45° and 50° F. It should never go below 40° for a longer period than three or four days. If the temperature of the cellar can not be kept up, a small stove with a connection to a chimney should be used to bring it up to the requisite point.

Some authorities think that dampness has nothing to do with causing dysentery in the cellar; but dampness in combination with a temperature below 40° for several weeks is a very common cause of dysentery in cellar repositories.

But what should be done if the bees do get dysentery? Suppose the food is bad, and the cellar one where it is not practicable to use artificial heat—at an outyard for example. If there are days during mid-winter when the bees can fly (and some localities do afford such weather for one day and possibly two), take the diseased colonies out on one such day and let them have a flight, then at night put them back in the cellar. A cleansing flight will do a world of good. Some authorities disagree here, but our own experience has shown conclusively, over and over again, that it does pay.

DZIERZON THEORY. — In 1845 the Rev. John Dzierzon enunciated what is now known as the "Dzierzon Theory," and thus in reality laid the foundation for much of our scientific and practical knowledge of bees. While he was not original in the discovery of parthenogenesis, he threw a great deal of light on the subject. (See Parthenogenesis, elsewhere.)

Prior to Dr. Dzierzon bringing out his



great discovery of parthenogenesis, he had been an ardent student of bee culture for over 20 years. He had invented a movable comb hive of his own. While it lacked the ease of manipulation as found in the Langstroth hive, there are many in Germany who still use it.

Dr. Dzierzon was not only a close observer of bee life, but he was at one time an extensive commercial beekeeper,

owning at one time as many as 400 colonies.

That the reader may know just what the theory was, the several propositions given by Dzierzon are as follows:

I. A colony of bees, in its normal condition, consists of three characteristically different kinds of individuals—the queen, the workers, and (at certain periods) the drones.

II. In the normal condition of a colony, the queen is the only perfect female present in the hive, and lays all the eggs found therein. These eggs are male and female. From the former proceed the drones; from the latter, if laid in narrow cells, proceed the workers, or undeveloped females; and from them also, if laid in wider acorn-shaped and vertically suspended so called royal cells, lavishly supplied with a peculiar pabulum, or jelly, proceed the queens.

III. The queen possesses the ability to lay male or female eggs at pleasure, as the particular cells she is at any time supplying may require.

IV. In order to become qualified to lay both male and female eggs, the queen must be fecundated by a drone or male bee.

V. The fecundation of the queen is always effected outside of the hive, in the open air, and while on the wing. Consequently, in order to become fully fertile, that is, capable of laying both male and female eggs, the queen must leave her hive at least once.

VI. In the act of copulation the genitals of the drone enter the vulva of the queen, are there retained, and the drone simultaneously perishes.

VII. The fecundation of the queen, once accomplished, is efficacious during her life, or so long as she remains healthy and vigorous; and, when once become fertile, she never afterward leaves her hive except when accompanying a swarm.

VIII. The ovaries of the queen are not impregnated in copulation; but a small vesicle or sac which is situated near the termination of the oviduct, and communicating therewith, becomes charged with the semen of the drone.

IX. All eggs germinated in the ovary of the queen develop as males, unless impregnated by the male sperm while passing the mouth of the seminal sac or spermatheca, when descending the oviduct. If they be thus impregnated in their downward passage (which impregnation the queen can effect or omit at pleasure), they develop as females.

X. If a queen remain unfecundated, she ordinarily does not lay eggs. Still, exceptional cases do sometimes occur; and the eggs then laid produce drones only.

XI. If, in consequence of superannuation, the contents of the spermatheca of a fecundated queen become exhausted; or, if, from enervation or accident, she lose the power of using the muscles connected with that organ, so as to be unable to impregnate the passing egg, she will thenceforward lay drone eggs only, if she lay at all.

XII. As some unfecundated queens occasionally lay drone eggs, so also in queenless colonies, no longer having the requisite means of rearing a queen, common workers are sometimes found that lay eggs from which drones only proceed. These workers are likewise unfecundated, and the eggs are uniformly laid by some individual bee, regarded and treated more or less by her companions as their queen.

XIII. So long as a fertile queen is present in the hive, the bees do not tolerate a fertile worker. Nor do they tolerate one while cherishing the hope of being able to rear a queen. In rare instances, however, exceptional cases occur. Fertile workers are sometimes found in the hive immediately after the death or removal of the queen, and even in the presence of a young queen, so long as she has not herself become fertile.

When this was put out originally in the *Bienenzeitung*, it called forth most strenuous opposition. Even the Baron von Berlepsch opposed it; but later on, when Italian bees were introduced, and the theory could be demonstrated, Berlepsch became its most staunch supporter. Indeed, he published a series of articles defending it; but there has been more or less opposition to it ever since. In 1895 M. Dickel made a violent attack on the theory, stating that all eggs laid by the queens were fecundated, and that the bees themselves determined the sex of the eggs by means of a secretion from the glands. For a number of years the European journals were filled with discussion, some supporting Dickel and some Dzierzon. Finally, in 1898 the Dickel theory was shown to be untenable.

Those who desire to see the original arguments in support of the theory will be interested in reading the booklet entitled "The Dzierzon Theory," by the Baron von Berlepsch, published by The A. I. Root Company. In the meantime the reader is referred to Parthenogenesis, where

more information is given on the subject. Some recent work by Nachtsheim seems to make Dzierzon's position still stronger.

Recent Evidence in Proof of Dzierzon Theory

Any reliable evidence either for or against Dzierzon's theory that the drones of the honeybee are produced from unfertilized eggs is at the present time of more than usual interest to beekeepers. In one of the issues of the American Naturalist, T. H. Morgan describes some experiments made by Newell at Houston, Texas, in mating Italian and Carniolan bees.

When yellow virgin Italian queens were mated with grayish Carniolan drones, both the workers and queens which came from fertilized eggs were yellow, from which it was inferred that yellow is dominant over gray. The drones also were yellow like the Italian mother. Now, this, too, might have been caused by the dominance of the maternal color (yellow); or, on the other hand, it might have been caused by the fact that in accordance with Dizerzon's theory these drones inherited from the mother only—that is, that the eggs that produced them were not fertilized by the drones. The experiment, therefore, as Morgan points out, is not decisive.

The reciprocal experiment was, however, decisive. When gray Carniolan queens were crossed with yellow Italian drones, the workers and queens were yellow as before, due to the dominant yellow of the father. But the drones were gray like the gray Carniolan mother and the pure stock of Carniolan drones. That is, they inherited from the mother alone. Otherwise they would have been yellow. This proves that they came from unfer tilized eggs. Prof. Morgan characterizes these crosses as furnishing the long-sought evidence demonstrating that the drones inherit only the characters of their moth er in accordance with Dzierzon's theory.

Parthenogenesis in Solitary Bees

According to Fabre's observations parthenogenesis also occurs among the solitary bees in the genus *Halictus.* The males of this genus do not appear until fall. After mating with the females they fly about among the flowers for a week or so and then all perish, none surviving the winter. The fecundated females hibernate in their old nests, in the crevices in stone walls, or in other retreats. With the return of warm weather they reappear, dig new burrows, and provision their cells with little masses of pollen and honey, on each of which they lay an egg. From these eggs come only females, and at this season of the year there are no males of this genus in existence with which they can mate. This first generation of females soon build new groups of cells, the daughters of a single mother extending the old nest, and all using the old entrance-tunnel in common. The eggs of these unimpregnated females give birth to both males and females; thus in the second generation both sexes are produced by parthenogenesis. After mating, the males die, and the females survive the winter and the cycle is repeated as before.

Fabre sums up as follows: "The *Halicti* have two generations a year; one in the spring, issuing from the mothers who have lived through the winter after being fecundated in the autumn; the other in the summer, the fruit of parthenogenesis; that is to say, of reproduction by the powers of the mother alone. Of the union of the two sexes females alone are born. Parthenogenesis gives birth at the same time to females and males."

taining two combs, with enough bees to cover them. On opening the boxes the queens were hunted out and put into introducing cages. In a number of these Italian shipments of queen bees a little insect upon the back of the queen bee and sometimes on the workers, was found. It was observed that these little "bugs" had a way of jumping almost like a fly. It was difficult to brush them off or catch them, so quick were those jumps. At the time they were called bee-lice, technically *Braula coeca.* They were never very numerous in the shipments of imported Italians, and little attention was paid to them. They were observed enough in Europe, however, so that they attracted attention. The first mention appears to be in 1740. In 1818 the species was named *Braula coeca* by Nitzsch. It was said to

Foot or Braula coeca, showing tarsal comb and pulvilli.

belong to the Pupipara, which is a group of diptera, or two-winged flies. All of these flies are parasitic, and some are wingless.

The *Braula coeca* attracted comparatively little attention until 1925 and 1926 when Virgil N. Argo took up its life history in real earnest. Originally it was thought that the insect was a parasite that somehow pierced the back of the bee and extracted the juices; but Argo has shown that the louse feeds on the nectar or honey which it extracts from the mouth parts of its host. It apparently does little or no harm, except to be a constant annoyance to the bee, and doubtless interferes with the bee's work as well as taking not a little of the nectar or honey, or possibly the pap which the bee is preparing to feed to its own larva.

The accompanying illustration shows an aggravated case in which the bee lice have clustered all over the queen.

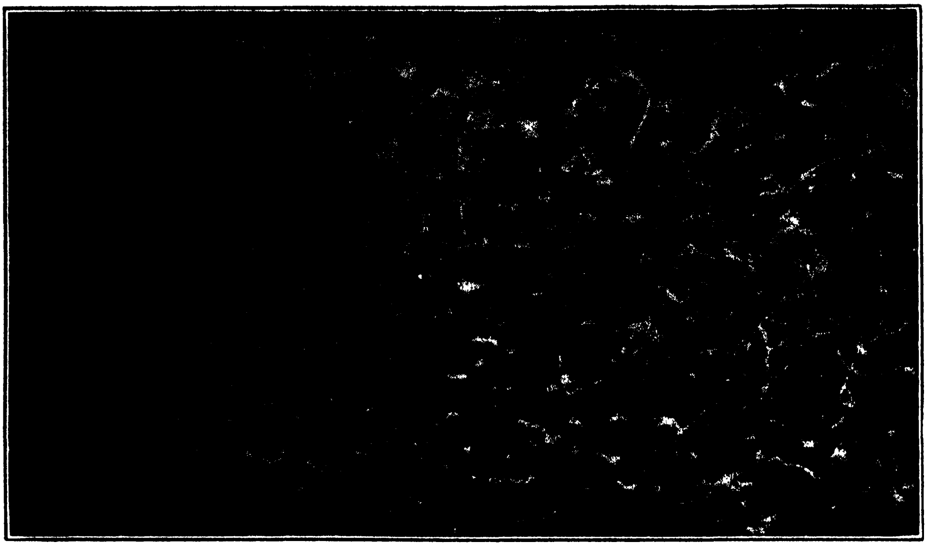
As a rule, when a colony is infested

Queen with newly emerged Braula clinging to her head, thorax, and abdomen.

there will be only a very few individuals and these remain on the back or on the side of the queen.

Were the depredations confined to the adult louse upon adult bees, little damage would be done. The real damage comes from the burrowings of the larvae of the louse on the cappings of the honeycombs. The eggs are laid under the surfaces of the honey cappings, presumably just before the cell is entirely capped over. These eggs hatch into maggots, which start to make burrowings or galleries on the under side of the cappings. At first the tunnels are minute, but as the larvae grow the tunnels become larger, although their greatest diameter is not over a half-millimeter, according to Argo. When the larvae are fully grown they hollow out larger chambers near the end of their tunnels and transform into pupae. They later push their way through the cappings, and are either white or yellow, the body-covering being soft and delicate. They gradually become darker and the soft skin becomes almost as hard as that of a beetle.

The burrowings or tunnelings are somewhat similar to the tunnelings of the lesser wax moth. (See Moth Worm.) But they are distinct enough so that there should be no mistake made. In a few cases these burrowings under the wax by the *Braula coeca* are so numerous as to do real damage to the cappings of the honey. This would perhaps not be serious in the production of extracted honey. It



Comb of honey showing extensive tunneling by larvae of Braula coeca. When such tunneling occurs in comb honey it is rendered unfit for market.

would certainly damage the sale of nice comb honey.

Fortunately the work of the *Braula coeca* has been observed in only a very few localities, and even there the damage has not been great.

They can easily be killed by smoking the colony vigorously with tobacco smoke. Apparently the pest will not stand as much tobacco as the bees. Bees will soon recover while the lice will be found dead on the bottom boards.

Skunks

Skunks are justly coming to be regarded as one of the most serious enemies of the beekeeper; and, owing to the legal protection given them in most states, together with their ability to multiply very rapidly, they are constantly becoming more numerous. Not only do they eat great numbers of bees, but by scratching at the front of the hives they keep the bees in an excited condition which is noticeable for several hours after the nightly raid of the skunk is finished. Young skunks that leave their nests and start foraging for themselves during midsummer and autumn seem to do the greater part of the damage, causing the colonies to dwindle rapidly at a time when they should be building up for winter.

Skunks may be poisoned by putting strychnine or Rough on Rats inside of small chunks of beef, leaving the beef at night on the entrance of the hive at which the skunks are working, remembering to remove it early the next morning. This could not be done safely where valuable cats or dogs would be likely to get it. Some beekeepers have reported good results by stirring the poison into eggs. Others are protecting their yards by fencing them in with four-foot poultry-netting, one foot of which is folded at a right angle so as to be flat on the ground on the outside of the fence, the outer edge being held close to the ground by being weighted or staked down. The skunks apparently do not know enough to start digging back of that part of the netting lying on the ground.

Ants

Certain ants in the more southern states, particularly in Florida and Texas, will attack a colony of bees and utterly ruin it. (For further particulars see Ants, subhead Ants in the South.)

Spiders

Spiders as well as toads seem to have a rare appreciation of a heavily laden bee as it returns to the hive; one should therefore be careful that all spider webs be faithfully kept brushed away from the hives, and that they have no corners or crevices about them to harbor such insects.

It was L. L. Langstroth who, just before he died, showed how spiders may be of value to the beekeeper. If, he said, they have free access to the combs stored in stacked-up hives in the apiary, there never need be any fear that moth worms or moth millers would be able to do any damage, for the spiders will shortly destroy them.

Wasps

Wasps and hornets sometimes capture and carry off honeybees; but, unless they should take part in the work in great numbers, there need be no solicitude in regard to them.

Mosquito Hawks

Mosquito hawks, sometimes called "devil's darning-needles," and "bee hawks," at certain seasons of the year are very destructive to bees in some of the southern states, particularly in Florida. They give more trouble along the Florida rivers, especially along the marshy lands, where they breed very rapidly. In April and May they have been known to come in such countless numbers that the sky is black with them. As the habits of these insects are predatory, they will attack any insects including mosquitoes and bees. When they are very numerous, the bees have learned the trick of staying in the hives, realizing that the mosquito hawks are their natural enemies. These insect hawks are so destructive at times that they weaken a whole apiary.

One year, when the publishers of this book had some 300 to 400 colonies on the Apalachicola River, their apiarist there estimated that the mosquito hawks did damage to the extent of a thousand dollars in four or five days. Arrangements had been made to move the bees north to escape this pest, but it was then too late.

Thieves

Thieves are sometimes troublesome at outyards. The best way to end their depredations is to put up a sign or two offering fifty or a hundred dollars reward for the arrest and conviction of the guilty parties. The thief is immediately warned that a price is upon his head, and that he had better stop stealing. It is seldom that the reward money is ever called for, and further anoyance is stopped. The American Honey Producers' League will furnish such signs for a nominal price.

The Worst Enemy

By all odds the most serious enemy to the bees and beekeeping is the careless or ignorant beekeeper himself, who harbors disease in the hives, either because he does not care or because he does not know any better. Such a man places in jeopardy the interests of every other beekeeper for miles around. While bees do not ordinarily fly over two miles (see Flight of Bees), and one is usually safe if he is that far from a foulbrood apiary, yet in the course of a year or two the colonies in the diseased yard will die, when bees a mile and a half away can easily rob out the honey from these dead colonies and carry the infection to their own yards. These in turn become diseased, forming new centers of infection reaching out a mile or perhaps two miles farther. This, in fact, is the way bee diseases proceed from yard to yard by robbing. To prevent this spread arises the need of foulbrood laws and bee inspectors. (See Laws Relating to Foulbrood; also Inspection.)

ENTRANCE DIAGNOSIS.—See Diagnosing Colonies.

ENTRANCE GUARDS.—See Drones.

ENTRANCES TO HIVES.—At the bottom of the hive is the usual and perhaps the best location for the entrance. Having the entrance below makes it much easier for the bees to retain the warmth of the cluster because heat rises. At this low level it is much easier for them to clean out dead bees, bits of wax and dirt. Flying bees in the North chilled in the spring or fall or incoming bees in the summer ladened with honey often fall short of the entrance. If the entrance is low they can crawl into the hive if on or near the ground.

In the South, where there is danger of burning grass or rising water after heavy rains, it is customary to put the hives up on benches or raised platforms as shown in the cut next page.

There is not so much chilly weather in the warmer climates and the bees that do fall short and alight on the ground will take wing again and land in the entrance. They can also, while in the hive, easily remove bits of refuse comb, dirt, or dead bees from the bottom-board.

Keeping Down the Grass

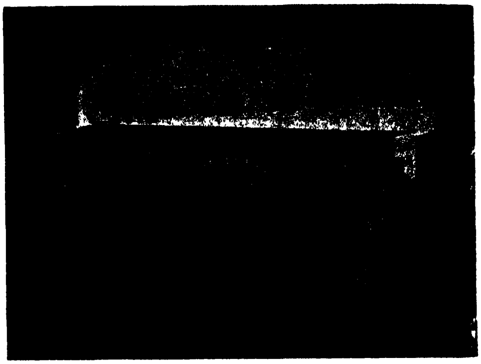
It is impossible to estimate just how much the loss in honey is when grass or weeds are allowed to obstruct the en-

trance when hives are close to the ground or near it; but, if the actual figures could be secured, the producer would be surprised. When it is such an easy matter to cut away the weeds, or keep them away from the entrance with a little sprinkling of salt or with a wide board, it is "penny-wise and pound-foolish" to wear out the wings of our little servants trying to pass this obstruction, at the same time delaying them when every moment counts. Farmer beekeepers especially seem to have the idea that bees will work for nothing and board themselves, and in three cases out of five one will find the entrances of their hives, what few they may have, all tangled up with grass and weeds. On mornings when there is a heavy dew such obstruction is very considerable.

Size of Summer Entrance

The proper size of entrance depends on the location, season of the year, size of colony, amount of protection, and whether the bees are wintered indoors or out. During the height of the honey flow the aperture should be as large as the bottom-board or hive will permit—not less than ⅞ inch deep by the width of the hive. If too small there will be insufficient ventilation, causing loafing and clustering on the front of the hive, often resulting in swarming. (See Swarming.)

It is a very interesting experiment to light a match and hold it in front of the entrance while the evaporation of nectar is going on in the hive. On one side the flame will be sucked into the entrance and on the other side the flame will be blown away from it. So strong is the current that the flame will be sucked in, in one

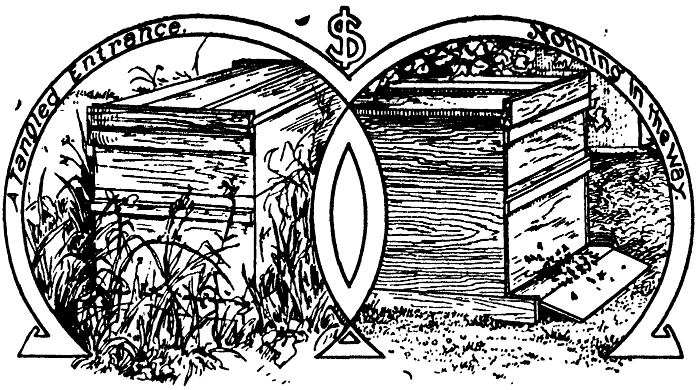


Entrance full width of hive.

case and blown out in the other. It shows that bees, like a series of little electric fans, are sucking fresh air in one side and forcing out the air laden with moisture from evaporation on the other side. The direction of the air current can also be determined by the use of a little smoke.

Nuclei or weak colonies must have no larger entrances than they can easily defend. They should be as small as possi-

In the Southern States it is necessary to put the hives up on raised platforms on account of high water or grass burned in the spring.



ble after the regular honey flow, for then it is that robbers are liable to rush in pellmell and overpower the guards of the little colony, depriving it of the scanty store it may have. (See Robbing.) A two-frame nucleus should not have an opening larger than will admit two or three bees at a time during the robbing season. When the honey flow is on, it may be larger; but it should be contracted as soon as the flow eases up.

Size of Winter Entrance

When cool weather comes on, the entrances of all colonies, both strong and weak, should be contracted, and kept so during the entire winter if bees are left outdoors. Formerly the practice was to allow the full size; but experience has shown that this is a serious mistake. There is no more reason why the bees should have their doors wide open in midwinter, letting chilling drafts blow in, than that their owners should leave their doors open. A ten-frame Langstroth hive should have an entrance not larger than ⅜ inch deep by two inches wide, the width of the entrance depending on the climate and the size of the colony. During very severe weather it might be still smaller. With a contracted entrance it may be necessary for the apiarist to hook the dead bees out with a wire two or three times during the winter, and possibly once in the spring; for in no case must the opening be clogged up.

Some recommend the use of a small entrance in the form of a circular hole from ⅝ to ¾ inch in diameter where the bees are packed in double winter cases, such as are described under Hives, subhead Double-walled Hives. A number of prominent apiarists all over the country have used very small entrances like this with excellent results during winter.

In California it is getting to be more and more the practice, even with large colonies, to contract the entrance to ½ inch wide, or a space where not more than two or three bees can pass at a

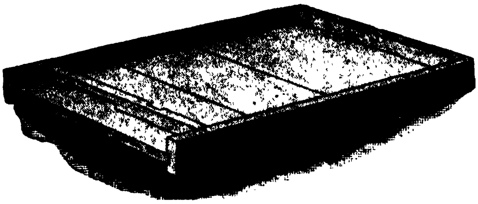
A colony with an entrance too small, where the bees have formed the loafing habit.

time; but, as the bees can fly nearly every day during the winter, they can easily carry out any dead that may accumulate. The object of the close contraction of the entrance in California is to obviate robbing and to hold the heat in the hives.

The use of very closely contracted entrances during the winter, as advocated by California beekeepers, can be practiced to excellent advantage in other semi-tropical countries during that part of the year when the days are warm and the nights cold.

It is customary to have some sort of cleat to reduce a wide entrance to a small slot. This, when inserted narrow slot down, reduces the opening to the proper size for out-door wintered bees. In clean-

ing out the dead bees the entrance-stop should be removed entirely, making the entrance the full size. Any dead bees that may have accumulated should be raked out and the stop put back. If it is discovered that the colony is weak, the slot should be reduced to one inch or less in width.



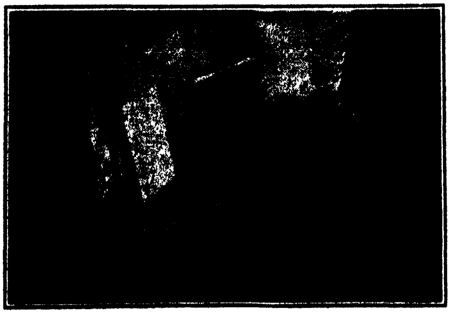
Bottom-board with entrance cleat in place.

The illustration shows how the entrance is provided for in a modern dovetailed hive. The bottom is made of an outside rim or frame, into which are inserted the floor-boards ⅞ inch thick. These slide into grooves so cut that on one side the bottom-board provides a ⅜-inch space, and on the other side ⅞. The usual practice is to use the deep side up, and an entrance-contracting cleat as shown.

While some prefer to use the shallow side of the bottom-board up the year round, it is better to use the deep side, and then make the necessary contraction of entrance with the contracting cleat as shown. During the warm part of the year, when bees need an abundance of ventilation (spoken of under Comb Honey, to Produce, and Swarming, Prevention of), the wide or deep entrance is used without the entrance cleat. As cooler weather comes on, or if the colony is not strong, the cleat is inserted in the entrance with a long narrow slot.

An Accessory or Winter Entrance

The authors have been using with considerable satisfaction in their double-walled hives a round hole entrance from ⅝ to ¾ inch in diameter about three inches above the regular bottom entrance, which may be partially or entirely closed. The purpose of this is to shut out the cold air as much as possible and at the same time to give the bees means of egress in case the bottom entrance is closed with dead bees or ice. Obviously this upper entrance would never be clogged with dead bees and it is high enough to be above the average depth of snow in most localities. A bottom entrance on the other hand may be clogged not only with dead bees, but with wet snow or ice. If this occurs it means the death of the colony in a short time as bees completely shut in will worry and die.



One-hole winter entrance.

Winter Top Entrance

There are some who recommend putting the supplemental entrance clear to the top of the hive either in a single or double brood chamber. In the case of the latter, it is the usual plan to allow the bees to pass through the hole in a super cover or honey board and thence through a wooden tunnel through the end cleat of the super cover. This has the merit of not mutilating the hive by a hole or slot and at the same time the right angle turn over the bees prevents a straight draft of cold air to the cluster.

In favor of these top entrances it may be said that they can not be clogged with dead bees. They are too high for the entrance of mice, and, what is of considerable importance, snow and ice is not liable to clog them as sometimes occurs with the regulation bottom entrances. It is also claimed that the winter packing does not get wet and that as a whole the colony winters better.

One or two beekeepers who have tried both the top and bottom entrances on colonies of the same relative strength and packing claim that top entrance bees came through the winter in much the better condition.

The objections to the top entrance are (1) that it causes confusion in the flight of the bees when the bottom entrance is closed and the top entrance installed. (2) Even if the top one is used both summer and winter there will be utter confusion in the flight of the bees when the upper story with its entrance is removed for inspection or taking the honey. When the

bottom entrance is used there is no such confusion when the hive is opened. (3) There is the belief that unless the size of the top entrance is carefully regulated to the size of the colony it may be too much of a good thing by letting too much cold air on the cluster. The author knows of one beekeeper who lost one yard of bees one winter because he provided too large an opening for his top entrances. Some experiments conducted by the Bee Culture Laboratory at Laramie, Wyoming, during the winter of 1933 and 1934, to learn the relative merits of top and bottom entrances gave results in favor of the regular bottom entrances considerably reduced. (See Gleanings in Bee Culture, page 215, for April, 1934.)

As yet the top entrances at the time this edition goes to press is in an experimental stage. It should not be tried out on too large a scale at first. The size of the entrance for winter should be relatively small. Something will depend, of course, on the size of the cluster and the climate; but the small hole entrance, ⅝ inch in diameter above the bottom entrance, which is not entirely closed, is a success.

Plurality of Entrances

There are some beekeepers who recommend and use a plurality of entrances—not because the bees will use the extra entrance, but for ventilation. Some bore holes in the back of the supers. Others stagger the supers during very hot weather, shoving the super forward or backward to leave a gap of about half an inch. While the bees will seldom use these openings for ingress or egress, ventilation is provided.

The practical beekeeper will soon discover for himself when and how to use a plurality of entrances, for much depends on the climate. Evidently it does not work so well with comb-honey production as it does with extracted; yet even this may be satisfactorily arranged.

Entrances for Indoor Wintering

Authorities differ as to the size of entrance that should be used for indoor wintering. Some argue that the larger the openings the better. A few go even so far as to urge that the bottom-boards be removed entirely, one hive piled upon two others, leaving an opening between the two lower hives of about one-third of the size of the entire bottom of the hive. Others advise a regular bottom-board, but an entrance two inches deep by the full width of the hive; while others recommend no larger entrance than the bees have during the summer.

The size of the entrances of the hives in a bee-cellar should depend on two factors—the size and temperature of the cellar itself and the size of the colony. Large colonies should have larger entrances than weak ones. If the temperature inside of the cluster at any time drops below 57 degrees Fahr., the bees will generate heat artificially, expand the cluster, and possibly start brood-rearing. The cluster should be kept at a temperature as near 60 degrees as possible. This will insure the greatest degree of quiescence or sleep. On the other hand, if the cellar is too warm, the temperature of the cluster will rise to a point of activity that will start brood-rearing. If it is too cold, or if the entrance is too large, the internal temperature of the cluster may fall below 57 degrees, with the result that muscular activity will be started, and in either case it means a too large consumption of stores, and possibly brood-rearing. As it would be impracticable to take the temperature reading of every colony of bees in the cellar in order to determine the size of the entrances, it is possible to arrive at it by putting a thermometer through the entrance, allowing it to rest on the floor board. The temperature at this point should be approximately between 48 and 52 degrees to insure 57 or more within the cluster. If it is below these points the entrance should be contracted. If the temperature on the floor board reaches 60 to 65 degrees the entrance should be enlarged. (See Temperature and Wintering Out doors.)

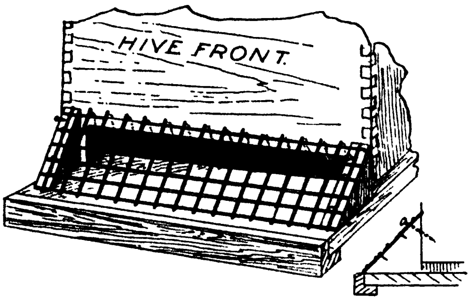
From these considerations it will be seen that no definite size of entrance can be prescribed for all the colonies in the cellar, unless the colonies are of about equal strength.

Colonies could be divided, perhaps, into two or three different groups as to strength. The temperature reading on a floor-board of about a dozen of each group should be taken, their entrances being regulated to insure a temperature of about 48°. All other colonies of the same group should have entrances of the same size.

Mice

Under the heading Enemies of Bees

reference was made to the deprrdations of mice during the winter. It often becomes necessary to screen the entrances



Entrance screened to keep mice out of the hive.

of hives put in the cellar. W. D. Keyes, of Wilkinsburg, Pa., uses a very simple device, consisting of two triangular blocks and a strip of coarse-mesh cloth, just coarse enough to let bees through it and yet exclude the mice. It is very quickly applied; and, if there is one to each hive, it will make very little expense, especially considering that a mouse on even one frame of young brood may do enough mischief in a single colony to pay the expense of the excluder. They will seldom gnaw a ⅜-inch slot in an entrance contracting cleat. For colonies wintered outdoors such a contracted entrance is all that is necessary for excluding mice.

EUCALYPTUS.—While there are a number of different species of this tree in California the one of the most importance to beekeepers is the blue gum (*E. globulus*). It is found in almost every town from San Francisco to San Diego. It is a tall stately shade tree, and a rapid grower. The bark is smooth and pale brown. The leaves are sword-shaped, 6 to 12 inches long. The flowers are solitary in the axils of the leaves and blooms from December to June. The honey is amber colored and inferior in quality and quantity. Occasionally there is a fair surplus; but as a rule only sufficient is gathered to stimulate brood-rearing. As the tree yields for so long a period it is invaluable not only for brood-rearing, but in some cases to prevent actual starvation. It also furnishes great quantities of cream-colored pollen. For further particulars of this and other species of eucalyptus see "Honey Plants of North America."

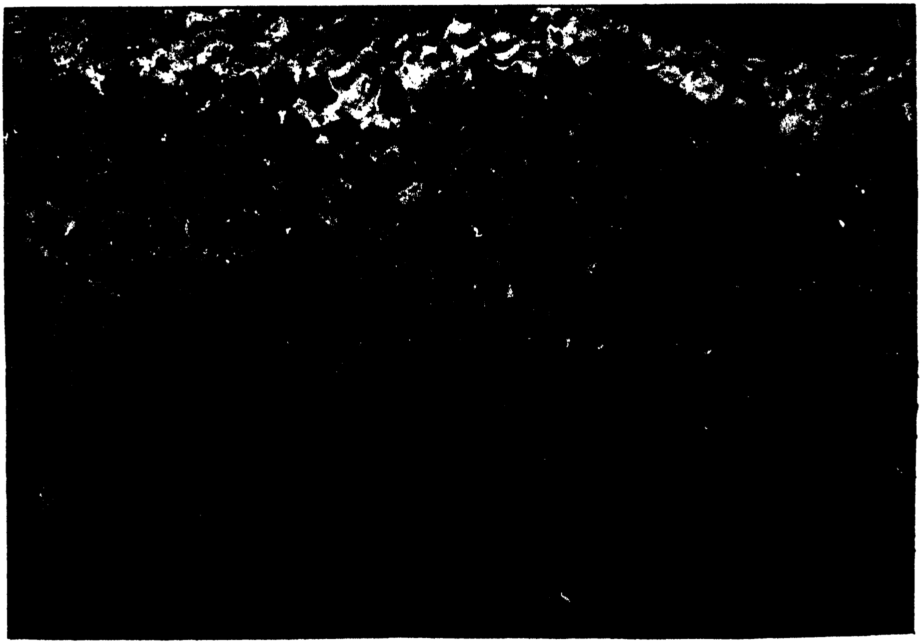
EXTRACTED HONEY.—Up to the year 1865 all liquid honey obtainable was pressed and strained from the combs—hence the term "strained" honey. Such a product is generally full of sediment consisting of particles of wax, pollen, propolis, and dirt. The more modern product of liquid honey is extracted from the combs by centrifugal force. A reel, holding two or more combs and revolving inside of a cylinder or can, throws the liquid honey from the cells, leaving the empty combs intact for the bees to fill again. (See Extracting, Extractors, and A B C of Beekeeping.) The honey is free from impurities and is not impaired in flavor by bits of pollen and propolis. Practically all the liquid honey on the market today is separated from the combs by the use of the extractor, and is, therefore, extracted honey. Occasionally there is a honey—for example, the far-famed heather honey of Scotland—that is so thick that it can not be readily separated from the comb by centrifugal force unless it is placed in a warm room for twenty-fours hours before extracting.

Extracted honey may be divided into two general classes, one suitable for table use and the other for manufacturing purposes. Among the first named are the light-colored honeys, such as the clover, basswood, sweet clover, alfalfa, sage, orange, tupelo, palmetto, and raspberry, all of which are of fine body and flavor, and of course suitable for use on the table. While it is not invariably true, yet generally the light-colored honeys are mild and delicious. The darker honeys are nearly always stronger in flavor and must be marketed in a locality where the consumers are accustomed to the flavor, or they must be sold for baking purposes. Some dark honeys like buckwheat, poplar and heather are highly prized as table honey. Hundreds of carloads of dark honeys are used by the large baking concerns, for no artificial product* that has ever been produced quite takes the place of honey for keeping cakes soft and moist for months. Some cakes, like honey jumbles, contain a larger percentage of honey than others. Honey is also often used along with molasses and cheaper syrups in baking and in some candies. (See Honey Candies, under the head, Honey as a Food; also Honey in Cooking.)

*Invert sugar, when it is cheaper than honey, is sometimes used as a substitute, but it lacks flavor. (See Invert Sugar.)

As is pointed out under Comb Honey, there is a slight difference in flavor between comb and extracted honey, owing to the fact that the latter loses some of its aroma in extracting and because it usually has to be heated to keep it in a liquid condition. Overheating, even for a very short time, impairs the flavor of honey. Some producers, in their eagerness to obtain all the honey possible, extract it from the combs before it is fully "ripened." Honey, when first stored in the cells, is thin and watery, and does not have the exquisite flavor that it has when evaporated and changed chemically by the bees, and sealed over. Honey which has been allowed to stay in the hive some time after it is sealed acquires a body and a richness that honey only partially sealed does not have. Some producers who use specially constructed evaporating tanks maintain that unripe honey may be evaporated by artificial means and made just as heavy in body as that evaporated by the bees. If an extensive equipment is used this is probably true, but the flavor is never as rich as though the honey had been left on the hive to be fully evaporated and capped over by the bees before being extracted. Practically all beekeepers who have tried to ripen honey artificially have failed, and the thin honey which they attempt to sell not only lacks in flavor and body, but in many instances actually sours, irreparably damaging future sales and injuring the reputation of the producer. Unless honey is coming in so fast that there is not a reserve of combs to take care of it, it is a serious mistake to extract unripe honey. It is not possible to produce an extracted honey that will have all the delicate aroma that is possessed before being removed from the comb, and every extracted-honey producer should err on the safe side by letting the bees do their part fully.

In 1870 A. I. Root extracted over three tons of honey from an apiary of less than fifty colonies. During the fore part of the season it had been allowed to become capped over; but during the basswood bloom, when the bees were fairly crazy in their eagerness to bring in the nectar, some of it was extracted that was little better than sweetened water. This granulated when the weather became cold, and nearly all of it had to be sold at a loss. Almost all honey will granulate. (See Granulated Honey, Science of Honey,



The comb after being taken from the extractor is as good as new and is ready to be filled again by the bees.

Honey, Spoilage of.) An unripe honey will do so, leaving a thin watery part which, if it does not sour, acquires in time a disagreeably brackish flavor. Unripe honey will ferment, developing gas and pushing the bungs out of barrels and corks out of bottles; and it may actually burst cans, to the disgust of every one. (See Honey, Spoilage of.)

New honey, before it is fully capped over, sometimes has a peculiar odor and taste. Where there is a great amount of goldenrod a disagreeable smell is noticeable in the apiary while the goldenrod honey is ripening. In a few weeks, however, all this passes away and the honey shows nothing of the former disagreeable odor or flavor. In certain localities where onion seeds are raised for market, the honey, when first gathered, has so strong a flavor of onions that it can not be used. Later on, however, much of the disagreeable quality disappears.

Even basswood honey, when first gathered, is so strong and has such a pronounced "tang" that it is often unpleasant. If left in the hives it greatly improves.

One season the extracting could not be attended to when the honey was capped over, and so the filled supers were raised up and supers of empty combs placed under them next to the brood chamber. This occupied but little time, and the bees were not hindered in their work. This was continued until the latter part of the summer, before any honey was extracted. While this honey was somewhat thicker and harder to extract, it had a richness of flavor that can be obtained in no other way. Of course, in localities where there are honey flows from two or more sources it is sometimes necessary to extract after each flow if one desires to keep the flavors separate.

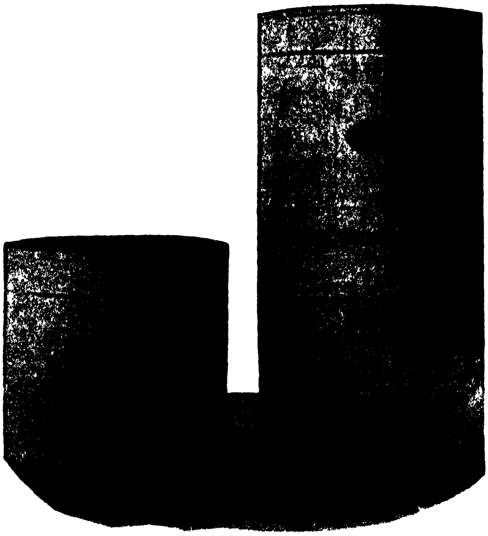
How to Keep Extracted Honey

It is usually best to sell the crop as soon as possible after its production. At other times it may be advisable to hold and sell later on. How to keep extracted honey if it is to be held for a few months, will depend on conditions. With a few exceptions all honey especially extracted, has a tendency to granulate and when it does, some changes may take place. After granulation, fermentation may or may not occur. If the honey has not been heated, it may ferment after granulation. To prevent fermentation of any unheated granulated honey, Prof. H. F. Wilson of the University of Wisconsin recommends that it be held in a temperature no higher than 50° F. or 55° F.; that at 60° F. it will ferment more quickly than at a higher point, and that usually all honey is slow to develop granulation at 75° F. A temperature of 80° F. is too high, says the same authority because serious deterioration in color or flavor may take place. All of which is true according to the experience of the author.

A honey that has been heated to 160° F. to prevent granulation should be put immediately into sealed containers and kept in living room temperature. An unheated honey should never be stored in a basement if the temperature is below 70, because 55° to 65° is the most favorable point for granulation, followed in a few cases by fermentation.

This whole matter of keeping extracted honey, heated or unheated, is explained more fully under Granulated Honey, Honey, Spoilage of, and Science of Honey. A large amount of otherwise good honey on the market is ruined or impaired by overheating or storing it under conditions where it will ferment and sour. Both Prof. Wilson and Dr. E. F. Phillips have warned beekeepers and honey buyers of the dangers of it and it will bear repeating here as well as elsewhere in this work.

Much that is said here will apply to comb honey except that such honey should never be allowed to granulate in the first place. It should be kept in a



warm room both summer and winter. It should, in fact, be sold before Christmas if possible.

Storage of Extracted Honey

Honey as it comes from the extractor is usually pumped or allowed by gravity to run through a strainer into a large-sized can or barrel. After the fine particles of wax or refuse rise to the top, the honey is drawn off through a bottom honey gate into square 60-pound cans or round pails with a self sealing top. It is not customary to allow honey to remain in these big tanks for an indefinite period as the honey might draw moisture from the atmosphere. If it is clean and well ripened it should be put into the marketing containers before it granulates. When that takes place it can be more easily liquefied than in the large tanks.

Storage Tanks of Galvanized Metal

Tanks holding more than 500 pounds are made of galvanized iron. Some objection has been made to this metal because of the zinc coating, but in the large-sized tanks no injury to the honey has ever been noticed. However, it would be a mistake to leave a very thin layer of honey for a long time in the bottom of a large galvanized tank, as the honey might take on enough of the zinc to be poisonous. In California and other western states where great quantities of extracted honey are produced, it is customary to store honey in large galvanized tanks, some of them practically good-sized cisterns above the ground. In hot climates the honey will remain liquid for some time and can be kept clear until cool weather comes on. If the honey has a tendency to granulate soon after extracting, it is not advisable to keep it for any length of time in large tanks. It should be drawn off into smaller cans of convenient size to handle after it granulates. In such cans it is not difficult to liquefy it, if desired. (See Bottling Honey and Granulated Honey.) It is an expensive matter to dig granulated honey out of a large tank. Some have attempted to supply heat by means of a steam-jacketed tank or by means of coils of steam pipes; but in most instances this, too, is expensive, and it is better to get honey into smaller cans as soon as possible.

In a few localities barrels are used for storing. They require careful watching, however, on account of the danger of leaking. The hoops need to be driven down occasionally to compensate for the slight shrinkage of the wood, of which there is danger, especially in a hot climate. The barrel should be thoroughly waxed on the inside as described under Barrels.

Is Extracted Honey Always Pure?

Years ago adulterated extracted honey was marketed in considerable quantities; but in later years, owing to the enactment and enforcement of pure-food laws, the adulterated product has been practically eliminated from the market. One may be nearly certain, therefore, that any liquid honey that he buys will be the pure product of bees. Some may be of poor quality, it is true; but that does not signify that it is adulterated. (See Adulteration of Honey, also Labels.)

Friction-top Pails

Among the smaller packages for holding a gallon or less the friction-top cans and pails are very popular. The opening at the top is very large, and this adds greatly to the convenience in filling. The

Extracted honey in friction-top pails.

Wedge shaped jars are very popular.

caps, when they are properly pressed into position, are tight and will not work loose. (See Granulated Honey.)

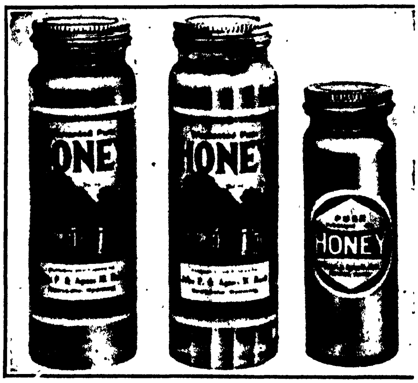
Glass Packages for Extracted Honey

The appearance of extracted honey is beautiful. For this reason the lighter grades should be retailed in glass instead of tin. (See Bottling Honey.) A tin package must depend upon its label for its attractiveness. Honey in clear white glass speaks for itself. The label does not need to be gaudy; in fact, it should serve only to call attention to the honey. There is a great variety of types of jars from the smallest tumbler to the two-quart Mason jars. Square bottles with large mouths using corks were very popular a few years ago and are still used quite largely. These are obtainable with a picture of a straw skep pressed in the glass on the front.

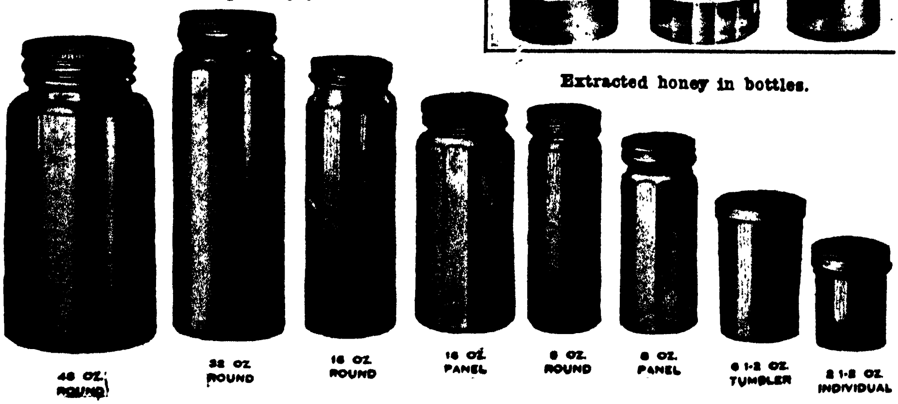
Of late years there has been a movement for a shorter jar with a mouth large enough to admit a spoon. Most housewives prefer the shorter or squatty jars because the spoon will reach to the bottom. This is not true of the tall jar. This is why the skep honey jar is popular.

Mason fruit-jars and jelly tumblers are popular because they can be bought anywhere, and no one objects to buying them with honey, since they are always useful. Whenever possible, select crystal-white glass rather than that of a greenish tint, for green does not show the honey to the best advantage.

The new skep honey jar.



Extracted honey in bottles.



Paper milk-bottles have been used for honey to some extent for local trade; but, while these are very satisfactory for granulated honey, they do not answer for long shipments of liquid honey that is not granulated. For this reason they are not very popular.

Extracted honey is one of the purest and best foods. It should not be classed with cheap syrups, and therefore it deserves the most attractive package.

EXTRACTING.—Before one can produce either comb or extracted honey he must have a large force of bees, such as he can secure with a food chamber. (See Food Chamber further on.) He may have ever so good a locality; conditions, so far as the honey sources are concerned, may be of the very best; but unless the colonies are strong—very strong—the crop of honey actually taken may be light. Even when the season is poor an intelligent beekeeper with a large force of bees of the right age in each colony may get a good crop. Success depends more upon strong colonies and good management than upon the locality and the particular season. But good management and strong colonies without a good year may mean a light crop or a failure.

Before the reader proceeds further, he will do well to read Building Up Colonies and Food Chambers, each found in its alphabetical order. The reading of these two articles will give the reader the general principles necessary to success. There are different ways of carrying out these principles. Much will depend upon the locality, the season, and the equipment. In some places there is a succession of honey flows with intervals of dearth or no honey coming in; but in most localities there is one main flow, during which the most if not all of the crop is secured. The season may last only ten days, or it may last three months, or even longer. In the white-clover regions in the North in an off year the flow may not last more than a week, although usually two or three weeks and sometimes a month of continuous honey flow may be expected. In the sweet-clover regions the season is later and may last from two to three months. This gives more time in which to build the colonies up to proper strength. In the southern states there may be a succession of minor honey flows, and when that is the case a little different management will be required. There will be so much early brood-rearing that the queen will be worn out. It may be necessary to requeen once or twice a year to get enough brood for the real flows to follow later.

We will first take up the clover regions where the honey flow comes on from the last of May until the middle of July. In these localities where clover is produced, bees will not be able to fly much before about the middle of April, and usually not much before the first or middle of May. The time is short, and every effort must be made to get the colonies strong for the flow. But brood-rearing will begin as early as February, to a small extent, and expand as weather conditions moderate. The reading of Food Chambers will show the importance of having a large amount of natural stores available, either in one story or in two stories of a Langstroth hive. Sometimes this food-chamber consists of a shallow story; at other times of a full story. It is much safer and better to have a large reserve of stores in the fall than to feed in the spring, and these stores should be made up largely of the best honey. While sugar-syrup stores are excellent for the extreme cold part of the winter, the natural stores are very much better for breeding.

The most successful beekeepers will, in the fall, have their bees in a single-story Langstroth hive, and a food chamber consisting of either a shallow or a full-depth hive-body on top of the brood nest. Along in February, if the bees are well packed or housed, some brood-rearing will start. The patches will be small, but as the season advances and the weather moderates, the amount of brood will increase. When settled warm weather comes on the brood and the cluster will extend from the food chamber down into the lower hive so that the brood should be found in both the upper and lower stories. As the season advances there may come a time when the brood-nest will be somewhat crowded; and should there be early spring flows, such as honey from fruit bloom or other sources, swarming may take place. To prevent this it is best to borrow a super of extracting-combs. If the colony is strong both the bees and the queen will enter this super, which may be placed at the bottom or between the food chamber proper and the brood-chamber. But when the main honey flow actually begins it

may be advisable in a clover region to confine the queen to one story and put that story, with the queen, at the bottom with a queen-excluder separating the other parts of the hive or supers from the brood-nest proper. (See Demaree Plan of Swarm Control.) Of course, there will be brood and honey in the upper story, but as the brood emerges this will give room for the bees, so that what was once a brood-chamber now becomes a super for the storage of honey. As the season advances another super of empty combs or frames containing full sheets of foundation may be added, but care must be taken not to give the room too fast.

How shall the beginner know just when he should add the extra super? If the brood-nest containing the queen is filled with brood and honey, and if the second story or possibly a third story is nearly filled with honey, and that not sealed, another super of empty combs should be added under the other supers that are partially filled or nearly filled. As the honey flow continues other supers may be added, or supers that are already capped over may be extracted and put back on the hive. At the beginning and during the height of the flow the supers of empty combs should be put beneath those partly filled.

Sometimes the rush of honey is so rapid that the bees will not be able to seal up any of the honey for the time being. Never extract the honey before the combs are at least two-thirds sealed. To secure the very finest honey, it would be much better to wait until they are all sealed. For this reason it is recommended to have an extra set of supers on hand, and at the close of the season, after the honey is all in and the combs capped over, the actual work of extracting may begin.

If, on the other hand, there are not enough supers to carry on to the end of the season, the beekeeper may be forced to extract in the midst of the flow. It will seldom occur that the honey will come so fast that none of the supers will be sealed over, so that one can begin extracting on supers most advanced, putting them back on the hive, but *under* the supers partly filled. When the season draws to a close (and this one can determine by the looks of the honey plants) it is best to add the extra supers, if any, on top. It is unwise to have too many supers on the hive toward the close of the season, because the bees should be compelled to complete those partly filled.

The foregoing is the general procedure that should be followed in the clover districts. In the localities where the season lasts forty or sixty days, or even longer, or where the honey flows are intermittent, it may be best to modify the procedure at the start by allowing the queen to have access to two stories at once; but this will seldom be necessary. Give her just enough room so that emerging brood will replace the bees that are dying. A good queen should do this providing she is not honey bound* in the brood chamber where she is confined. If she is not keeping up the force, steal brood from a weak colony, or from a strong colony if it is very strong.

Several modifications can be carried out in putting on the extra supers to fit different localities. (See Demaree plan of placing supers.) If the season is short there is danger of getting the work started in too many supers at once. This is particularly true in the production of comb honey. If the flow will last only about ten days or two weeks, at the outside, great care must be exercised in not giving too many supers for the bees to fill. Whether the season is long or short, any supers given toward the last should be placed on top, and not under those partly filled.

Where there is a series of outyards the beekeeper will not be able to put the supers on at exactly the right time. He will have to make a general trip, and many of the supers will have to go on a week or ten days ahead of the time that the bees will actually need them. Where one can visit yards only once a month it may be necessary to put on empty combs two or three weeks ahead of time. Usually this gives too much room at the beginning, but when help is expensive and hard to get and distance is great, one is often compelled to do the thing when he can, or lose swarms and a honey crop.

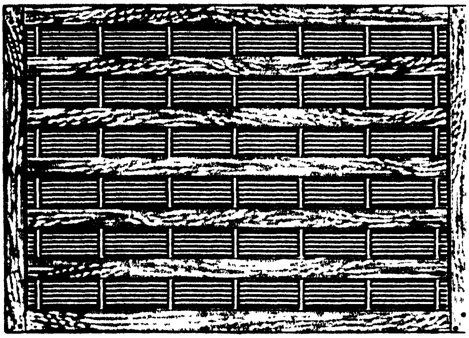
Shall Queen-excluders be Used?

In all of the foregoing it has been assumed that queen excluders would be used at the proper time and place. Some producers, however, feel that such appliances are not needed. The author is convinced that they are worth many times their price, for the reason that they can

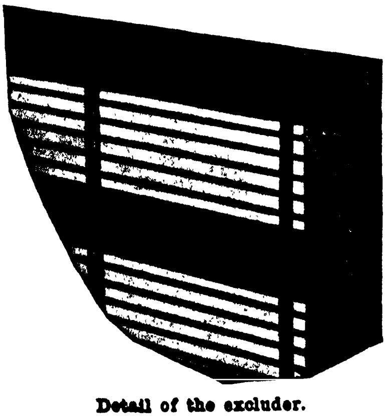
*This means that there is so much honey in the cells that the queen has no room to lay.

be used not only to curtail brood-rearing, but to confine the queen to a particular part of the hive. If the queen has access to all of the supers as well as the brood-nest, it is very difficult to find her in the first place, and in the second place she is liable to have brood scattered in the extracting-supers, making it necessary to take extra precautions not to throw off the young brood with the honey.

As will be explained further on, combs should be extracted dry, and if there is brood, especially unsealed brood, the combs can not be extracted clean. (See Demaree Plan of Swarm Control; also Swarming.)


Wood-wire queen-excluder.

The objection has been made to excluders in which perforated metal is used that the edges are rough, making it difficult for the bees to pass back and forth. This difficulty is entirely overcome when the wood-wire excluder is used, as shown in the accompanying illustrations. These wires have a rounding edge, are perfectly smooth, and are spaced exactly the right distance apart to shut out all normal queens and yet allow worker bees to pass back and forth freely. Perforated metal excluders have almost gone out of use. (See Drones.)


Detail of the excluder.

The Control of Swarming

The control of swarming in the production of extracted honey is accomplished much more easily than in the production of comb honey. The same general principles, however, apply in both cases. For a complete discussion of the whole problem, see Swarming, subhead Prevention of Swarming, and Swarm Control; and also Demaree Plan of Swarm Control.

The reason why control or prevention is easier in the production of extracted honey is that empty combs can be put on the hives, giving immediate room for the storage of the honey. In giving extra room in the form of comb-honey sections and comb foundation the problem is not so easy because the foundation must be drawn out into combs, and it sometimes takes a little time before the bees begin to work in the supers. All of this is fully explained under Comb Honey Production and under Swarming.

What Kind of Hives to Use for Producing Extracted Honey

For most localities the best results will be secured with the standard ten-frame hives of Langstroth dimensions. There are, perhaps, some who would prefer the ten-frame Jumbo hive with an extracting-super of Langstroth depth; and there are a few who would consider a twelve or thirteen frame hive, Langstroth depth, most suitable. But the objection to these very large hives is that they are not standard and are very heavy to handle; but where the individual units are smaller it is easier on the beekeeper.

Either the eight or ten frame Langstroth hive is standard. Either is light enough so any one can pick it up, transfer it to a wheelbarrow or cart, on which it is then carried to the extracting-house. If the time ever comes when the beekeeper wishes to sell out he will get a better price for something that is standard than if he has some freak or odd equipment that the prospective purchaser is not used to and would not like.

Another thing in favor of the Langstroth dimensions is the fact that they are just right for the brood-nest or for

the extractor. Where one uses hives of extra depth, like the Jumbo, he is compelled to have a super of shallower dimensions, as it is not practicable to extract from the large deep frame. By adopting the Langstroth depth throughout one not only has standard equipment, but his supers and frames are interchangeable, either for breeding purposes, for extracting, or for the production of comb honey. This one fact alone should decide the extracted-honey producer in favor of the Langstroth dimensions, even if there were no other considerations. Moreover, when brood-nest and super are one and the same the cost is less.

If one is well advanced in years or happens to be a woman, an eight-frame hive is a little easier to handle. But the ten-frame is much more of a standard, and the authors strongly advise adopting an equipment that is not only uniform but universal in this country.

There are some few extracted-honey producers who prefer the ten-frame Langstroth brood-nest and a shallow extracting-super having frames 5⅜ inches deep. This equipment is standard, and has the further merit that the supers are much lighter than the full-depth Langstroth brood-nest. Shallow frames are very easy to uncap, and require a little less wiring. On the other hand, it should be clearly understood that nearly two frames must be handled to take the crop in place of one. This makes extra manipulation in uncapping, in taking the frames out of the supers, and putting them in the extractor.

Why Standard Equipment

Perhaps the greatest objection to the large hive or brood-chamber is that it is not flexible enough to enable the beekeeper to control the placing of brood or honey in such a way as to control swarming where there is more than one honey flow during the season. The same objection applies, though to a less extent, where there is only one or a main honey flow. If the brood-nest is made up of one or more units a congestion of brood or honey (or both) can, by intelligent manipulation, be easily relieved, and swarming, the great obstacle to a maximum crop, can be brought under control. When the brood is confined to one large unit there will usually be a rim of honey of two or three inches right over the brood. As the season advances the bees will crowd the queen more and more with honey until she is honey-bound. The condition is greatly aggravated where there are two or three honey flows during the season, as in the South, where the large single brood-chamber is losing out. In such a hive it is not possible to separate the brood and honey. (See Demaree Plan of Swarm Control; also Food Chambers.)

When, however, the double-unit brood-nest, made of standard Langstroth brood-chambers, is used it is possible to borrow an extracting super of empty combs from a colony that does not need it and place it at the bottom and the two supers of brood and honey on top. The queen is put on the empty combs, where she is confined by a queen-excluder. The queen will have unlimited room to lay, and this is an important factor in swarm control. The brood, as it emerges from the former brood-chamber, now on top, will automatically make room for the storage of honey. By this manipulation the congestion is removed at once both for the queen and the bees. Such treatment would be impossible with a single large brood-chamber of Jumbo size. To use another Jumbo brood-chamber or even a super of Langstroth dimensions would not be practicable. Even if it could be done, the Jumbo body would become a super, and Jumbo frames are too large for either uncapping or extracting.

There are various ways of manipulating standard equipment for swarm control and a maximum crop of honey. Any one of these methods makes it possible to scatter the brood.

For a further consideration of the subject, see Swarm Control and Swarm Prevention under Swarming, Demaree Plan of Swarm Control, and Food Chamber.

How Far to Space the Combs

Most Hoffman frames are made on a spacing of 1⅜ inches from center to center. This is correct for brood-rearing. (See Spacing of Frames.) For the production of extracted honey there should be nine combs to the ten-frame super. This will make the combs fat or thick enough so that they will uncap more easily, and at the same time not leave any low spots uncapped to be gone over again with the knife. These fat combs are better likewise for the machine uncapper described further on.

Some have argued for eight combs for the ten-frame super. The objection to this

spacing is that the combs are liable to be fat on one side and lean on the other. This makes it difficult to uncap the lean side, and, worst of all, leaves the combs with one thick side and one thin one.

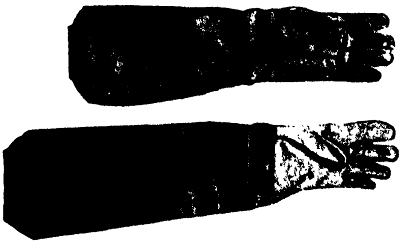
Nine combs to the 10-frame super have proven by experience to be much better than 8 combs to the same super. The difficulty is that the bees, when the combs are spaced so wide apart, are inclined to build spurs of separate combs between the frames themselves. There is the additional danger that the combs on the wide spacing will be bulged so much more on one side than on the other. On the nine-comb spacing these difficulties are overcome almost entirely, and yet they are fat enough to leave quite a surplus of wax and cappings.

Removing the Filled Extracting Combs from the Hive

The beginner at least should remember that, when one is working with strong colonies, especially if the bees are busy going to and from the fields, the operator is liable to be stung, not once, but several times unless he uses extra precaution. Bees do not like to be interrupted in the midst of their work, and for that reason it is advisable to use not only plenty of smoke at the entrance but smoke between the supers just as they are being lifted up. When smoke is not applied at the entrance when the supers are pried apart, one will often be severely stung in separating the supers, with the regular hive tool. Bees will be much crosser if the atmosphere is a little chilly or damp. They will likewise be cross immediately after a honey flow which is stopped suddenly by a rain or by cold weather.

How to Protect from Stings

Many beekeepers will work with bare



Bee gloves.

hands and wrists, using only a bee veil over the head. In taking off honey the bees will rush out, stinging the hands and the wrists; go up the sleeves, and cause not only annoyance but interruption, to say nothing of pain. To avoid as much punishment as possible the operator is strongly urged to wear a pair of gloves with long sleeves sold by all bee equipment dealers. Many beekeepers prefer to have the ends of the finger tips of the gloves cut off. Most of the bees that rush out and attempt to sting will strike higher up on the glove or sleeve where no damage will be received. Gloves

Bee suit.

should never fit snugly over the hand. A loose fit will prevent stings from reaching the skin. (See Gloves.)

While one can wear old clothes, it is much better to have a one-piece overall suit. Preferably these should be white. The bottom of the trouser legs should be tucked inside of the socks, or they should be folded and held tightly in place by trouser guards, such as are used by the bicyclist.

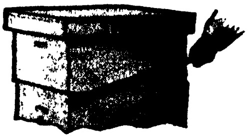
How to Break Propolis Connections Between Supers

There is not much use in trying to separate the supers from each other unless one has a very heavy screwdriver, or, better yet, a regular hive-tool made for the purpose. When the supers are heavy and

filled with honey, it is very much better to use super tongs. The regular hive-tool is apt to mar or damage the edges of the supers, especially where propolis is bad. The super tongs, however, make it possible, by means of the leverage provided, to slide one super on top of another,

Hive tool. This, like the smoker, is almost as indispensable tool in the bee yard.

breaking propolis connections. Just as soon as the super is slid far enough to leave a gap, the smoker in the left hand should be ready to apply smoke to prevent cross bees from rushing out. If the bees seem to be vicious use plenty of smoke. These tongs are sold by bee equipment dealers.



Super tongs. This saves marring the edges of the supers.

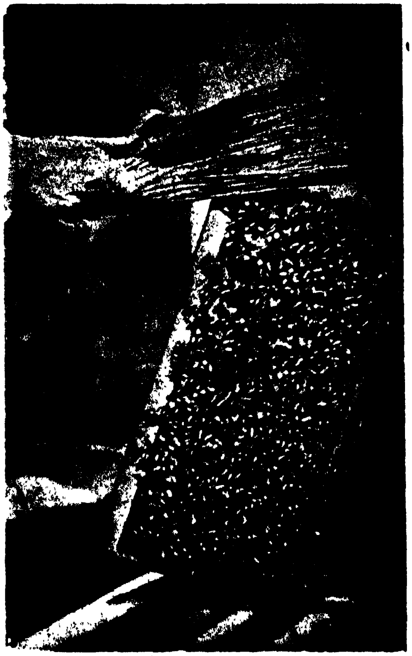
If there is more than one super to be removed from the hive, loosen them all with the super tongs, and then lift off one at a time and set them on a wheelbarrow or on the cover placed upside down. If a super filled with bees and honey is set upon the ground, it is liable to crush bees and cause more stinging.

Removing the Bees from the Combs

First of all, one should have a suitable brush. One of the best for this purpose is a long whisk broom with the strands considerably thinned out. An ordinary brush broom for brushing clothes will not answer unless half or two-thirds of the strands are cut out. The beekeepers' supply manufacturers have brooms especially made for the purpose. They are cheap in price and very effective.

Bee broom.

After shaking most of the bees in front of the entrance, lay the broom flat against the top edge of the comb as shown in the accompanying cut. It is then given a downward sweep with the strands lying crosswise of the comb. A couple of sweeps will clear all the bees from the comb on one side, after which the operation is repeated on the other side. As fast as the combs are cleared of bees they are put into an empty super standing on a wheelbarrow, which should be close at hand to avoid useless steps.



Manner of brushing bees off the combs.

There are some who prefer a brush of another type with the bristles made of horsehair mounted on the side of the handle. For temporary purposes some people use long grass or weeds for brushing the combs.

German bee brush.

After either the brush or broom has been used for an hour or two it should be dipped in water to remove the surplus of honey, which is of course always sticky. For this purpose keep a pail

How to hold combs in shaking to dislodge bees. A quick downward stroke of the palms removes the bees.

of water standing near if a large amount of work is to be done.

There are some who remove all the supers from the hive, put an empty super on top of the hive, and then shake and brush the bees back into the empty super.

Brushing the bees off the combs in front of the entrance.

This puts the bees back into the hive again without the necessity of crawling through the entrance and interrupting the flight of the incoming bees.

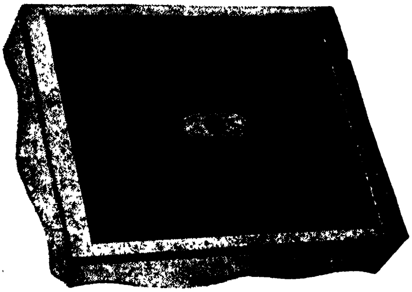
The Bee Escape or Carbolic Acid Fumes for Removing Extracted Honey

Commercial or professional beekeepers do not use the brushing or shaking method of removing bees from combs prior to extracting because it requires so much more work when simpler and less expensive methods are available. Either the bee escape or the carbolic fumes method, as described under Comb Honey, How to Produce, are very much to be preferred. As the bee escape has to be put on the night before, requiring a return trip to the yard, the carbolic acid method has of late been coming more and more into favor. By its use the combs can be freed of bees on one visit to the yard. The combs can be taken home, extracted, and returned, all in one day. Where the bees are all at the home yard the bee escape has a little the advantage. If one uses a portable extracting outfit or has only one small extractor the carbolic acid plan enables one to remove the combs freed of bees, and extract the honey at the yard all on one visit.

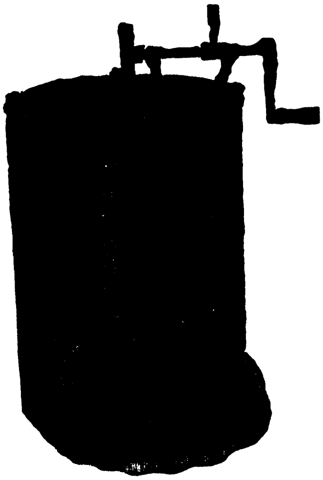
The Hodgson Ventilated Escape Board

Where a preference is had for the bee escape method, the Hodgson ventilated escape board as here shown is generally

used. The bee escape in a solid board in very hot weather or in the case of a very strong colony does not give sucicient ventilation. It was urged that the combs of honey after the bees had left them would get cold during the night, making it more difficult to extract them. The ventilated escape board allows the heat of the cluster to ascend into the super keeping the combs warm.



Where the escape is mounted in a solid board, there is danger on hot days of the honey melting down from heat. With this type there is no danger as the bees will keep the temperature down in the lower hive.



Root two-frame reversible extractor. It is a little quicker and easier to reverse the combs with this machine than it is with the two-frame Novice shown on the next page. It is likewise provided with a slip gear so that the crank can be disengaged, allowing the reel having ball bearings to spin for some time after the hand has been taken from the crank. The acquired momentum will throw out more of the honey. It costs, however, twice as much as the Novice two-frame and is much larger and heavier.

Taking the Combs to the Extractor

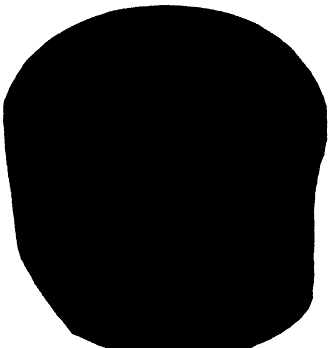
Various four-wheeled and two-wheeled carts and wagons have been devised for carrying combs from the hive to the extractor, or to the truck if the combs are extracted at a central extracting-plant as described under Buildings, page 127. The most suitable and at the same time the cheapest is a common light wheelbarrow such as can be secured at any hardware store. When the combs are shaken and brushed, they should be set down in an empty super placed on the wheelbarrow. This saves an extra handling, and when that super is full, another super is filled, and so on up to the extent of two or three, when the whole load is wheeled to the extractor or truck.

When it comes to lifting the supers off the hive, two men can take hold of a super and lift it up very easily and place it on the wheelbarrow. While one man is wheeling the load to the extractor, the other man is loosening the supers on the hives, blowing smoke into the entrances, and by the time the operator with wheelbarrow returns they are both ready to lift the supers off and free them of bees.

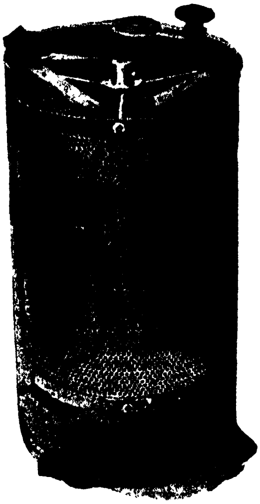
EXTRACTING EQUIPMENT FOR THE BACKLOT BEEKEEPER OR FARMER

The equipment for taking honey from the combs for the one who has only a few colonies of bees need not be elaborate or expensive. A hand-driven two or three frame extractor, an uncapping knife for removing cappings from the combs before extracting, a lamp stove, and an uncapping can with means for allowing such cappings to drain out, are essential.

Either of the extractors shown next page will easily take care of 25 or 50 colonies of bees. They are, in fact, ideal for the backlotter or amateur. They are portable,



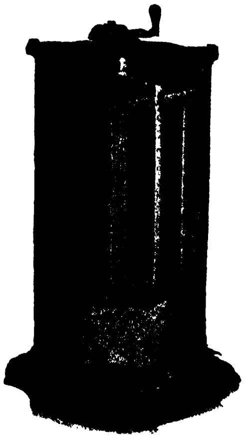
Bench extractor. It extracts 90 per cent of the honey from two combs without reversing. It is not as rapid or thorough in its work as either the two or three frame extractors where the combs stand on end. It will take care of a dozen colonies. Where there are more any one of the other machines should be selected instead.



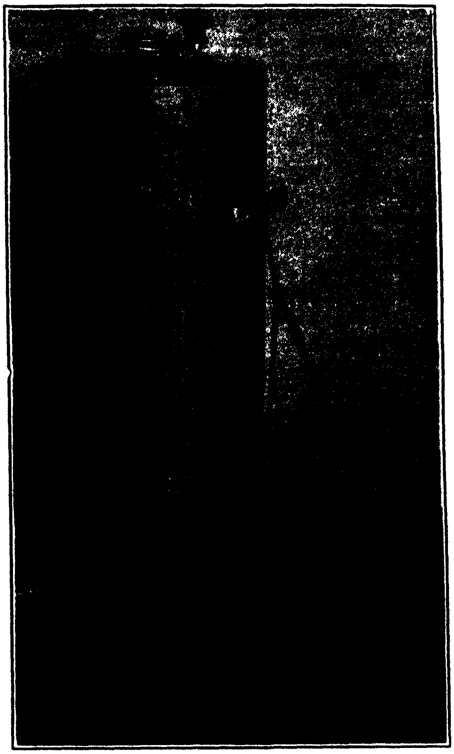
Three-frame Novice extractor with screen to separate the honey from the cappings. This and the next machine are the best for beginners.

light and inexpensive. The three-frame machine is especially recommended because the reel consists of a cylinder of perforated metal sides and bottom. As soon as the extracting is over the three supports for holding the combs can be easily lifted out, after which the cappings and adhering honey can be dumped into the reel. The centrifugal force, when the handle is turned, throws the honey out from the cappings, leaving them comparatively dry.

The two-frame extractor is somewhat lighter and smaller. It has no provision for separating the honey from the cappings. However, one can reverse the



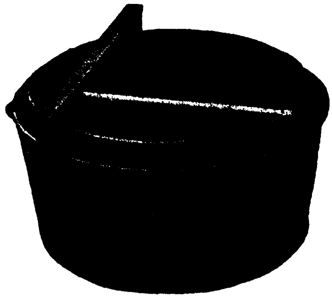
Two-frame Novice extractor.



Method of anchoring the extractor to the box and the floor by means of ordinary bailing wire. Wire is made taut by twisting the strands with a stick as shown.

combs more rapidly by using two hands. The reel is turned to such a point that both hands can reach down, pull out the combs, give them a half-turn and then reinsert them. In the case of the three-frame Novice the combs must be reversed one at a time.

When the two-frame extractor is se-



Uncapping can. This separates the free honey from the cappings as they fall from the uncapping knife. The cappings are held in the perforated basket while the free honey drains into the tub below.

lected it is necessary or important to have an uncapping can, either factory made or home made. This consists of a tub, an inner smaller tub of perforated metal, sides and bottom, and a wooden cross arm with a narrow one-inch square stick. Projecting through the wide bar is a nail point extending up about one inch. On this nail point the combs are balanced while being uncapped, as will be explained further on. From the inner basket which receives the capping, the free honey drains off by gravity into the outer tub and then on through a hole in the bottom into another receptacle below. These cappings that drain by gravity, however, are not quite as clean as those dried by centrifugal force in the three-frame extractor. If one feels he can afford it, it is quite an advantage to have not only a three-frame extractor but an uncapping can also.

The cappings as soon as they drain dry or are whirled dry can be melted up. It should be remembered that capping wax is the very best.

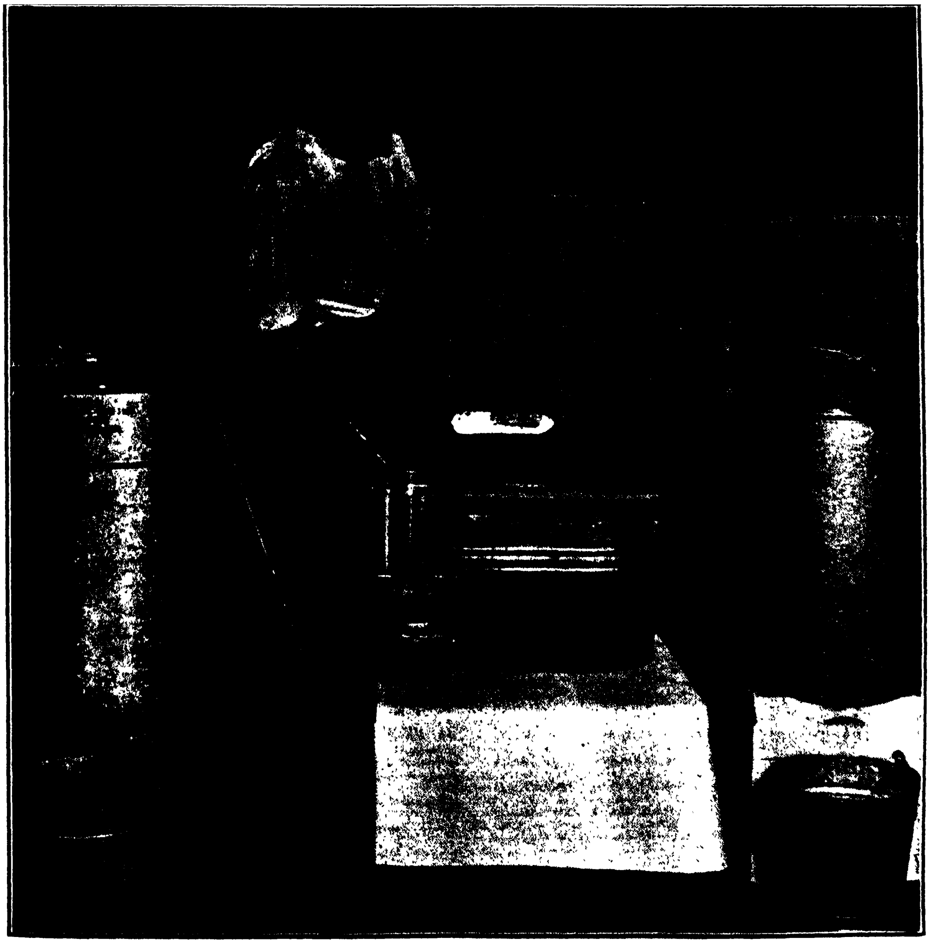
To cut down the expense of the extracting outfit to the very lowest point possible, one should select the three-frame extractor and at least one uncapping knife. It is better to have two knives for reasons that will be explained later. The rest of the equipment can be made up of untensils found in any home. The cut on next page shows the equipment based on a minimum cost using utensils such as a housewife finds necessary for her housekeeping.

A much better method of anchoring an extractor is by the use cf three rods with turnbuckles to take up the slack. These rods can be obtained from the dealer.

The extractor must be elevated high enough so that the honey can be drawn into the pail. The pail of honey is poured on top of the cheesecloth covering the honey tank on the right. In place of the regular honey tank with honey gate an ordinary wash tub may be used, but as in the other case, a cheesecloth should be used as a strainer to catch small particles of wax and dead bees, as well as particles of dirt that may accumulate. The cut, page 263, shows a three-frame extractor anchored on top of a box of suitable height so that when the honey gate is opened honey can run by gravity into the pail beneath. A box for holding two 60-pound square cans in which extracted honey is ordinarily shipped, laid on its side, answers a very excellent purpose. Owing to the fact that the combs are rarely of equal weight, it is very necessary to anchor the extractor down

to the floor in the manner shown. This can be best accomplished by three stay rods, each provided with a turnbuckle to take up the slack and three hooks that can be hooked into the floor with a link or two of chain or turns of wire so the stay rods can connect with the before-mentioned hooks. These stay rods should be placed so they will be an equal distance apart and yet placed so as not to interfere with the operator shown at the right. The turnbuckle should be turned until the rods are drawn taut. While the stay rods are not expensive, one can use in their stead hay bailing wire looped under the two ends of the cross arm of the extractor and then drawn taut. The slack of the wires is taken up by twisting a stick around the two wires until the wires sing like a fiddle string. The detail of the stay rods and the loop wires are shown in the engravings on pages 261 and 262.

It should again be mentioned that before attempting to extract, the combs should be equalized in weight as far as possible. New combs just built from foundation should be extracted by themselves, and in all cases should be equalized as to weight. Old combs heavy with honey should likewise be extracted by themselves. An old comb full of honey should not be put into the machine with other combs only partially filled, and therefore weighing half to two-thirds as much as the old combs. An old comb containing a



Amateur home extracting outfit. Three-frame extractor, left, uncapping outfit made with wash-boiler, lamp stove for heating a 10-pound pail of water, honey knives, and a honey tank, at right.

good deal of pollen should not be extracted with other combs for after the honey is extracted the pollen comb is still heavy and therefore more out of balance than ever. A heavy comb and two light ones will cause the reel to be out of balance and if the reel is turned at high speed it tends to break the anchorage or greatly loosen it. Do not attempt to do any extracting until the combs are brought to as near even weight as possible by selection. The reel is then turned at slow speed extracting about half of the honey from one side of each of the combs. The extractor is then stopped when each of the combs is reversed presenting the other side. The crank is turned very slowly, gradually accelerating the speed until top speed is reached. After the second side is as clean as possible, the combs are reversed, finally taking out the remnant of the honey in the first side.

The home-made uncapping outfit is shown in the middle of the cut on page 263. This consists of an ordinary wash boiler, a wooden cross arm on which to balance the combs as shown, a small lamp stove, and a ten-pound honey pail containing water which is kept hot. It is an advantage to have two knives. These knives should always be sharp and hot. After one knife cools it is placed in the pail of hot water and the other knife is used. While one can get along with one knife, it is much better to have the two and use them in alternation as explained.

The cross arm over the wash boiler consists of a stick a little longer than the wash boiler itself. The two ends are notched in such a way so as to slip over the rim at the two ends of the boiler. In the center of this wooden cross arm is a nail projecting upward about an inch. On this the comb is balanced as shown in the large cut.

The honey tank at the right is covered with cheesecloth. After the wash boiler is about half-full of cappings and honey, it should be emptied on to a coarse wire cloth covering a galvanized tub, not shown in the picture. The free honey will run through the wire cloth and the cappings wet with honey will gradually drain dry.

Extractor Room

The beginner or one who has a small number of colonies does not need a small building for extracting as is used by those who have a hundred or more colonies. A basement is an ideal place provided there is an easy approach to outdoors. If access is had only through inside cellar stairs, it should not be used. An ordinary garage would answer a very excellent purpose, but as it is rather difficult to screen a garage it may be necessary to use a screened-in porch having a self-closing screen door. This would make an ideal place and after the extracting is over the floor can easily be washed by using water from a hose or hot water from a pail with a scrubbing brush. In case none of these places are available it may be necessary to use the kitchen.

If the honey is to be extracted during a honey flow there will be no danger from robbers but if the work is to be done after the honey flow is over, a rainy day should be selected or the work done at night. In all cases, a screened-in building should be used if possible. Provision should be made in the screen to allow stray bees that come in with the combs to escape through the honey-house bee-escapes. There should be several of these placed at the top corners of the screens of the doors and windows because bees, during extracting, will accumulate in the room. They will go naturally to the screen and finally work themselves over to the escapes after which they will return to the hive.

How to Extract

We have now provided the equipment and the room where the extracting is to be done. The extracting combs should be placed in supers or hive bodies wheeled into the room or building and placed just back of the operator who will do the uncapping. Combs are then uncapped and run through the machine and after extracting they are put back in the hive bodies. To prevent dripping on the floor, these supers of combs should be placed upon several thicknesses of strong paper to catch the drip, or better, placed in a dripping pan. After the combs are extracted they should be returned to the hives as soon as possible. If there is an extra set of combs, they should be placed upon the hives at the time of taking out the filled ones; but the average beginner will have only one set of combs. He will then be under the necessity of returning the combs either the same day or the next morning, after extracting, if the work is done at night to avoid robbing.

In addition to the extracting equipment, there should be a couple of pails of warm

water and wash cloths. One member of the family can turn the reel of the extractor and extract the honey while the other uncaps the combs.

How to Uncap

To uncap, combs should be balanced upon the nail point of the cross arm of the wash boiler. A hot knife should be taken out of the hot water in the can on the lamp stove. Some prefer to start at the top of the comb and cut down, but the majority seem to find it easier to cut upward. The knife is moved back and forth, carefully cutting off the film of wax that covers the cells. Sometimes the knife can move clear to the top with the capping adhering. When it reaches the top the whole sheet of capping will drop down in the boiler. If any cells have been skipped they can be uncapped after the main part of the comb is finished.

As already explained, it is an advantage to have two uncapping knives and use them in alternation in order that they may be as hot as possible. The edges should be occasionally sharpened.

If any honey gets on the floor it should either be mopped up or washed clean with a wash cloth. It is right here that the housewife can be of great deal of assistance because, if her kitchen is used, she should have something to say about keeping the floor and utensils as clean as possible.

It is important to keep the floors clean of honey while extracting, for if one walks in the honey and then outdoors he is liable to invite robbers. A careless beginner may get the whole neighborhood aroused on account of robber bees stinging chickens, dogs and cats. (See Robbing.)

In the case of the professional man, the business man or the farmer, the work of extracting would probably have to be done at odd hours or at night.

While it is possible to extract the supers of combs and immediately return them to the hive whence they came, the probabilities are that the average person will find it more satisfactory to take off all the filled supers and run them into the building or extracting-room. Later on they can be extracted at night, on some Saturday half holiday, or some day when it is raining. In the meantime, if the bees do not already have the room, supers of empty combs should be given them to be filled, and when filled these can be extracted and the others extracted first given to the bees.

If one has only one set of extracting-combs to the hive he will be compelled to run them into the extracting room, extract them, and put them back on the hives as soon as they are empty. When this is done, however, a day will have to be selected when the bees are flying, the weather warm, and all conditions favorable for opening the hives.

Care must be taken in all cases that no dripping honey be allowed to get onto the ground or where robbers can get at it. The honey, when extracted and strained, should be put into the regular containers, square cans or tin buckets, and sealed so that if robbers should get into the building they will not cause any trouble. (See Extracted Honey.)

Cleaning the Wet Combs

It is the usual practice to put the slightly wet combs from the extractor back on the hives for the bees to clean up. It is the only safe way in a yard located in a town or city. They can, of course, if the season is over and no more honey is coming in, be stored in the supers in the honey house; but the smear of honey will quickly granulate, and when the combs are put back on the hive, the new honey will quickly granulate because there is left the "seed" of granulated honey of the previous season. Better by far let the bees clean up the hives before the next season. (See Granulation.)

There are a few who advocate and practice putting the combs right after extracting out in the open air and let robber bees clean them up; but this is a very dangerous procedure that may lead to a lawsuit as will be seen from the following letter that appeared in Gleanings in Bee Culture, page 566, for 1931. Here is what W. H. Eastman of Whiting, Kansas, says:

Danger of Exposing Wet Extracting Combs to Robbers in the Open Air

In previous years, I have usually returned my wet extracted combs to the bees to be cleaned, putting the supers of combs over an excluder. They cleaned them nicely but usually they put the honey back into a few cells in the same comb and capped it, seldom going to the trouble of carrying it below.

I read about some one who sets the supers of wet combs out in the open and allows the bees to carry away the honey, which he said they did in good fashion. So I decided to try about four supers.

My bees are located near the home and also near two public roads. Not long after I set them out, I realized I had started something. At first, I noticed great gobs of bees on the sides of the supers of empty combs. They literally

held on by the hat full until the bunches got so heavy they fell to the ground. I thought I would get up close and get a good picture. Did they meet me half way? They did better, they met me all the way—a regular bayonet charge.

Presently the air began to fill with bees like a monstrous swarm. I recalled that some people from this county were killed in a neighboring state, the accident having been apparently caused by a lady driver becoming excited when some bees got in her car. The sight of those bees almost swarming to the roads did not reassure me.

Of course they finally cleaned up the combs and the excitement subsided, but I made a firm resolution that if wet combs were set out in future it would be far from home and highway.

EXTRACTING ON A LARGE SCALE

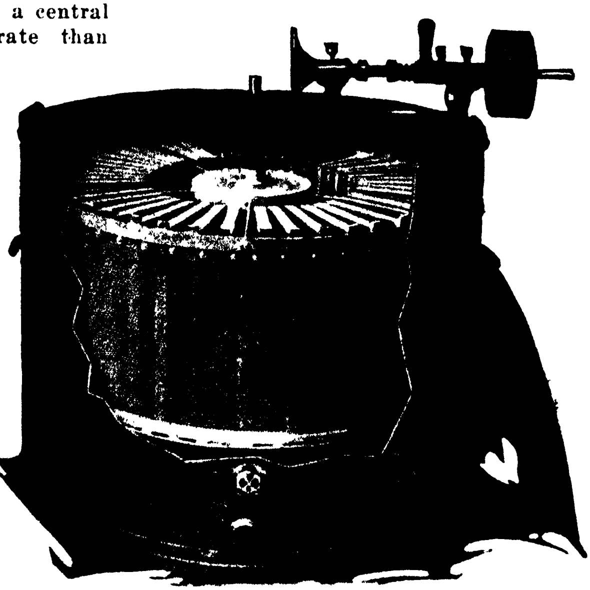
As already pointed out under the head of Buildings, there may be three methods of extracting the honey from the bees at the home yard and the outyards. One is to have a central extracting-plant operated by electric motor or a gasoline engine at the home yard, or at any one of the yards in the center of a group of other yards. The equipment at a central station is much more elaborate than would be used in the case of a portable plant or of a small plant used at each of the yards.

If one does not use a central plant he will be compelled to have a small extracting outfit at each of the yards such as has already been described, or a portable plant mounted on a truck. An outfit at each yard, as pointed out under Buildings, is more expensive than one central plant that extracts the honey from all the yards, the combs being carried back and forth to the hives.

There are only a few beekeepers now who prefer a medium-sized portable extracting-outfit that can be carried from yard to yard on a truck or wagon. Sometimes these portable outfits are mounted permanently on the truck, the honey being extracted on the body of the truck itself; and sometimes the portable outfit consists of a light equipment, two-frame extractor, uncapping-can, and knife, that are unloaded, put up in the small extracting-building, when the honey is extracted, after which the whole outfit is loaded on the truck, together with the honey.

Extracting at a Central Plant

While the portable outfit cuts down the first cost of equipment over one used at each of the yards, the labor involved is such that the average honey producer having from 100 to 500 colonies considers it much more satisfactory and more economical in the end to have one efficient large extracting-plant at some central point, the whole outfit kept under lock and key where both the honey taken and the equipment can be protected. It is customary to have these central extracting plants operated by electric motor, or gasoline engine if electricity is not available. It is likewise the practice to have a little stove or some sort of heating appliance so that the room can be warmed if necessary at any time during late fall or winter. If the temperature of the room is down to fifty or sixty, or even lower, the difficulties of extracting honey are very much greater than if it is up to 70° or 80° F. When the weather is cold or chilly, the fire should be built in the stove two or three days ahead of the time when extracting will be begun. While one can extract in a cold room with the proper appliance, the honey will be so thick and gummy that much of it will stick to the combs, and there will be more danger of breaking the combs than when the room is warm.

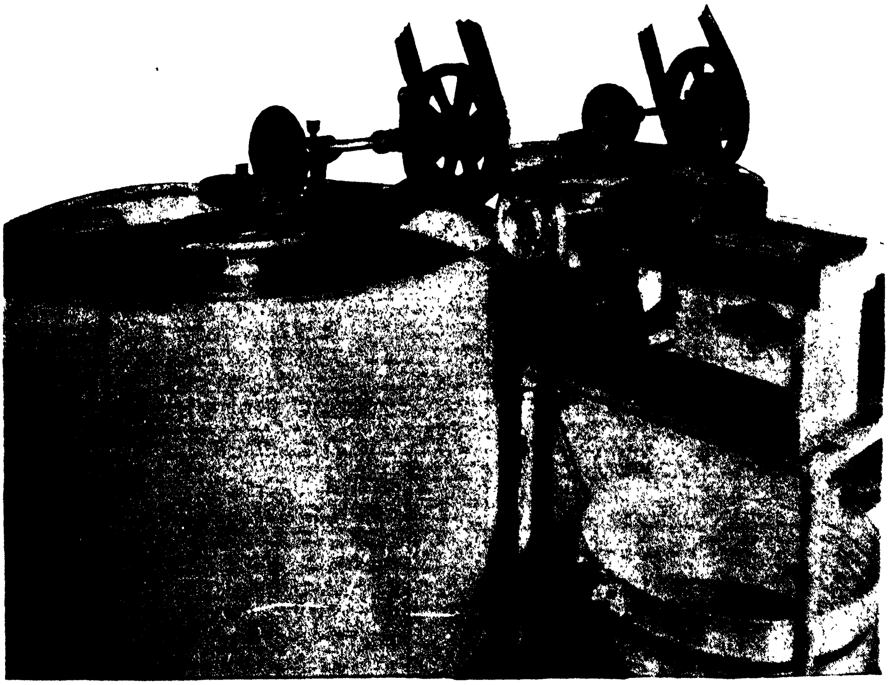


45-comb Simplicity extractor.

A central extracting plant has the further advantage that the work of taking the honey can be deferred till after the honey flow, when the beekeeper has more time at his disposal.

While one can use a hand-driven extractor of two or four frame capacity, the difficulty of securing competent help at the right time of the year is such that one can better afford to have either an electric motor or a gasoline engine to drive a 45-comb machine. It is not practicable to go beyond the four-frame capacity of extractor when hand power is used. The capacity of such a machine is so limited that it will pay one to adopt the big machine. The engine or the motor will easily take the place of a good strong man in turning the crank of a four-frame machine. While he can not satisfactorily operate an eight-frame or larger machine, the motor can run an eight, twelve, or better yet, a forty-five comb machine, do the work faster, more efficiently, and cleaner than can be done by any hand-power machine, large or small. The beekeeper who operates several hundred colonies and uses only a hand power machine is wasting valuable time, and losing honey. A motor or engine will get more honey out of the same combs.

If it is finally decided that power of some sort shall be used, then what size or kind of an extractor should one adopt? Something will depend upon conditions. By turning to the next subject, Extractors, it will be noted that there are a number of different sizes and styles from which to select. If the honey is exceptionally thick and the frames are rickety and loose at the corners, or not well made, and if the majority of the combs are not reinforced with four horizontal wires threaded through the end-bars, the eight-frame reversible operated by one-horse-power motor or one and one-half horse-power gasoline engine should be selected. But no beekeeper should be foolish enough to try to get long with crooked combs and rickety frames. It would pay him well to buy new frames, standard factory-made, and foundation (Three-ply), and then give the bees well-wired frames the next season, gradually working out the crooked combs. The old wax will go a long way toward buying the new equipment, and when it is once installed it would be possible to use the large 45-comb Simplicity



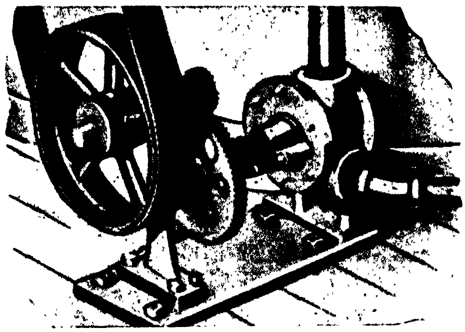
A battery of two 45-comb radial extractors. One receives the combs as fast as they are uncapped, and the other is extracting. When the still machine is full it is started up and the other machine is emptied of combs and refilled. Note that the power uncapping machine stands midway between the two machines so that it can feed either machine. This arrangement is ideal and the one the author recommends for the large producer. Where there is one extractor the plan shown top of page 129 is recommended.

that is far more efficient in every way.

It will be assumed, however, that Mr. Beekeeper feels that he can not afford to make the change. He may think, likewise, that he may not be in the business very long and that therefore he can get along with what he has. He will find the equipment shown on page 276 very satisfactory.

Honey Pumps for Extractors

In practically all central extracting-plants a honey-pump for removing the honey from the extractor as fast as it is removed from the combs makes it possible to have the entire equipment upon



Honey pump attached to the extractor.

the same floor level. If the honey-pump is not used the honey will have to run by gravity into a lower story of the building, necessitating a two-story building or a basement (see Buildings) or the extractor will have to be put upon an elevated platform so that the honey can run into a pail or tub. This, however, makes it necessary to operate the machine at an inconvenient height for putting in and removing the combs, and to be constantly emptying pails of honey into the straining-tank. When, however, the honey runs by gravity into a lower story, it can pass into the straining-tank below. But if honey runs into the basement it must be elevated again to the ground floor outside. If the extracting-room is on the second story of a building, then all the combs must be elevated to the second floor. It will be apparent that the advantages are with the honey pump from the standpoint of both first cost and labor.

Limitations of Reversible Extractors

If combs are new, tender, or unwired, frames rickety, not well nailed, nor accurately cut at a regular bee-supply factory, and the honey thick or cold, it is advisable to extract the first side of the combs partially at a slow speed, then reverse and extract the other side clean, first starting at a slow speed and gradually accelerating until high speed is reached, then reverse to the first side and complete the extracting.

There are many beekeepers who, whether they use good combs or poor ones, consider it an advantage to extract the first side partially, reverse, extract the other side, and return to the first side. Unless this practice is carried out, the combs, after reaching high speed, are liable to be imbedded in the wire cloth, making it difficult to remove them, and in some cases tearing them in the process of removal. Where the radial type of machine, such as the Simplicity, is used, no such precaution need be taken. Combs (if in good well-wired frames) are put into the machine, and both sides extracted at the same operation, no reversing being necessary, but it is necessary to speed up very slowly.

Non-reversing or Simplicity Extractor

It is assumed that the great majority of the readers of this work will decide that it is "penny-wise and pound-foolish" policy to try to get along with crooked combs in rickety frames. The old wax melted up will nearly pay for modern factory-made frames containing full sheets of Three-ply comb foundation well wired. By comparing the factory prices it will be seen that the multiple extractor holding only eight combs costs almost as much as the 45-comb Simplicity extractor. While the capacity for taking the honey is not quite in proportion to the number of combs, the work is accomplished with a great deal less labor and the combs are cleaner when they come out of the machine.

As labor is expensive and difficult to get at the right time of the year, it will pay the beekeeper who has a series of outyards to purchase not only the 45-comb Simplicity radial extractor but the power uncapping outfit. One great advantage of a central extracting plant is that it can be located in town where electric power is available. With all these appliances, one with a single helper, or oftentimes alone, can handle the crop from 500 colonies, although when that number is reached it is usually found advantageous

to have two Simplicity extractors and one Root uncapping machine, as shown on pages 267 and 272.

At the end of the day's work or at the noon hour the cappings can be forked into the machine after putting in the sectional pieces of sheet metal in the bottom. The Simplicity extractor therefore not only extracts the combs clean, but it extracts the honey from the cappings, leaving nothing but dry cappings, comparatively speaking, to be melted up. This saves the expense of a capping melter, uncapping box, and a steam uncapping knife.

Power required is one-and-one-half or two-horse-power electric motor, or a two or two-and-one-half horse-power gasoline engine. Select a pulley for the motor or engine that will permit an extractor speed of 275 revolutions per minute.

If the honey is thick, running over 12 pounds to the gallon, or the honey is cold, a speed of 225 or even less may be safer. Too high a speed will break the combs. It will take longer to clean the combs at the lower speeds.

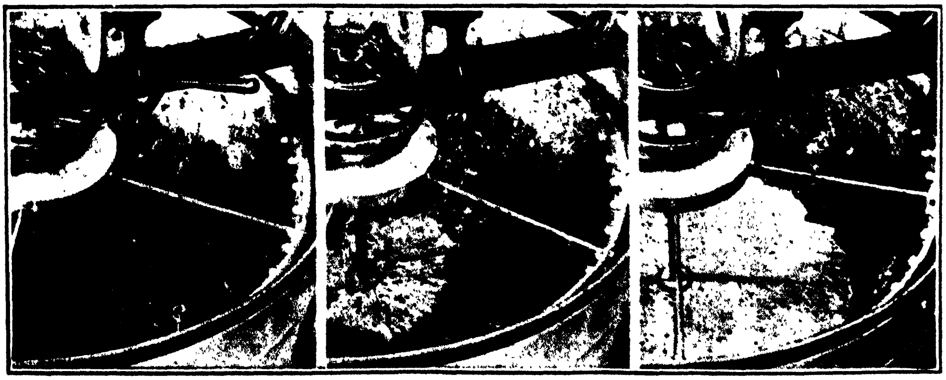
A Simplicity extractor, like every other machine, should be well anchored to the floor. Directions are sent out by the manufacturers that will explain how this is done. The anchor rods should be placed equally distant around the can, locating the screw hooks on the floor six or eight inches out from the bottom of the can in order to give better support. These rods can then be tightened by means of turnbuckles. If the extractor is located on a concrete floor it may be necessary to construct a wooden platform upon which to place the extractor and

When lever (A) is in a vertical position, and (B) is turned four to six half turns, horizontal pressure is exerted on the spring, thus thrusting the driving disk against the fiber pulley on the vertical shaft. The rate of acceleration is controlled entirely by the turnbuckle B. For best results the speed must be constantly increasing, but the pressure must be so light that four to five minutes are required for the extractor to reach full speed. New, full-depth combs will not stand much speed until the bulk of the honey is out of the cells. Shallow combs, or full-depth combs that are old and tough, will stand a quicker acceleration. Stopping and starting are controlled entirely by lever (A).

the equipment that goes with it, then fasten as before explained.

Loading the Extractor

Load the combs with top-bars resting against the perforated metal surrounding the reel and with the bottom-bars toward the center shaft. Be sure that the lower end-bar fits down between the lugs in the lower casting to receive it. If the



Extracting the honey from the cappings with a Simplicity extractor. At the close of the day or during the noon hour, about 100 pounds of cappings, wet or practically drained, are dumped into the machine, after putting in the four sectional pieces to close the bottom. The cappings should be placed evenly around the reel. The machine is started up and allowed to run fifteen minutes when the dried cappings are forked out and the process repeated if there are more cappings.

supers containing the combs are anywhere near uniform in weight, no great attention need be paid to the balancing of the combs in the extractor. The great bulk of the honey will be extracted before full speed is reached, thus tending to equalize the weight of all the combs. Nevertheless, it is not advisable to put light combs on one side of the extractor and heavy ones on the other. An occasional light comb may be put in without unbalancing the machine. It is very important with this machine to start with low speed. The reel should gradually accelerate and then when two-thirds or more of the honey is out of the combs full speed should be reached. If the reel accelerates too rapidly some combs will be broken.

The combs should be so placed that the top-bars will be next to the outside.

In order to get satisfactory results with a Simplicity or any other extractor, the directions for operating sent out by the manufacturers should be very carefully read and followed. If the beekeeper is not a mechanic nor used to machinery, he would do well to call in some practical mechanic who can do the work for him.

For discussion of the relative merits of the various types of extractors, see **Extractors**.

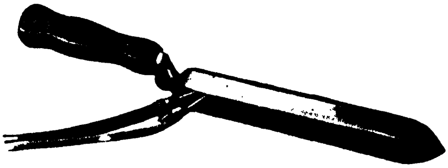
Uncapping the Combs

While a large honey-producer can use two plain uncapping knives kept hot in a pail of hot water and used in alternation, as previously explained, he will find that the steam knife kept continuously hot by steam through hose from a small boiler will save time and labor. A plain knife from a pail of hot water is constantly cooling and as it cools it looses its cutting efficiency. The steam knife is kept, by the circulation of steam, always at a degree of heat at which it will do the best work. This saves strain on the wrist; and, what is of considerable importance, the cappings will slide off more easily than from a knife constantly cooling.

How to Use the Steam Uncapping Knife

This is used in the same way as the two plain uncapping knives immersed in hot water as described on page 265. With the steam double hose connections only one knife is used with the advantage that the steam keeps the knife constantly hot. The plain knives just removed from the hot water are constantly cooling and almost immediately lose their efficiency in cutting. A cool or dull knife instead of cutting smoothly, makes ragged edges of the cells, while the steam-heated sharp knife makes a clean cut and with less effort.

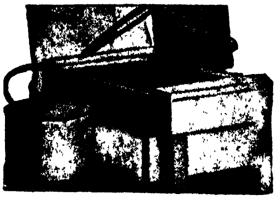
The source of steam comes from a small copper boiler. A little oil lamp stove will



Hand steam uncapping knife.

easily keep the water boiling so that there will be plenty of steam at low pressure.

The cappings as fast as they are removed can fall into an uncapping can previously described, or they can lodge in a capping melter that melts the cappings as fast as they are removed. The wax falls on to a hot surface kept hot with hot water by oil lamps below. Both the honey and the melted wax flow into a wax separator. On cooling the wax forms a cake at



Capping melter.

the top and the honey is drawn off at the bottom. This honey is then mixed with the regular honey taken with the extractor. The honey separated from the hot wax

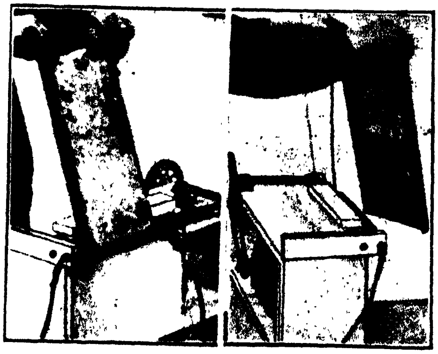
is not quite as good as that taken with the extractor and the tendency of late years is to separate the honey from the cappings by centrifugal force described on page 261 and 269.

Capping-melter and Small Boiler for Steam Knife

One can, however, uncap by beginning at the top and working downward, but the cappings have more of a tendency to stick to the surface of the comb.

The Power Uncapping Machine

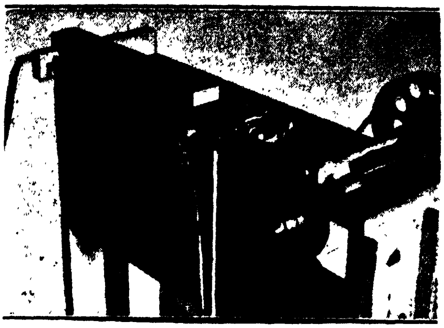
To use a hand steam knife all day puts a rather severe strain upon the right hand and the wrist. If one can afford the extra expense he will find that the uncapping-machine making use of a rapidly oscilating steam knife will do the work of about two people with a hand steam knife, and do it much more easily and better. The combs, when they come from the machine, are as smooth as a board.



The power uncapping machine in operation.

The machine operates on the same general principle as the steam knife, with this exception, that the knife is mounted in a cross-head operated by means of a crank, making about eight hundred strokes a minute. The operator picks up the comb by the end as shown in the cut above, shoves it downward, the cappings dropping down into a tub beneath. The other side is treated in the same way. There is no strain upon the arm — the weight of the comb seems to do the work, the hands being used merely to guide the comb and hold it steady against the support. Depressions may be uncapped as easily as bulged combs, and all at the same speed.

This machine works so rapidly that the cappings are run into a common tub or tin can of a suitable size, and at noon or at night they are forked out and put into the Simplicity extractor. It is seldom that this uncapping-machine would be used without the 45-comb radial ex-



Knife side of the power uncapper.

tractor, and as they naturally go together, the extractor itself will remove the honey from the cappings at the end of the day's work much cleaner and better than any other device that has ever been made.

If the Simplicity extractor is used the cappings can be run into an ordinary tub or barrel, then at noon or at night pour the wet cappings into the extractor and throw out the free honey from the cappings. This is altogether the fastest way of freeing the honey from the cappings. However, when one is using any one of the other types of extractors it will be necessary to use a capping-melter that melts the cappings as fast as they accumulate and frees the hot wax from the honey, placing the honey in one receptacle and the wax in another. (See page 201.) When the extracting or uncapping work is done the cappings are all disposed of, and as soon as the hot wax cools off the cake can be removed from the honey beneath, where there will be only a very small residue of honey left. Others, perhaps, would prefer the Root uncapping-can for the drainage of the cappings. The cappings can be dropped into this can, and when the basket is full it can be allowed to stand for a while, when the free honey will drain out. But one objection to this is that there will be considerable honey left in the cappings.

Two or More Simplicities in Tandem

If the reader will turn to the subject of "Buildings" and particularly to page 129, he will find in the illustrations that Mr. Hiltner, immediately after he runs his

combs through the power uncapping machine, places them on a turntable that will hold just enough to fill a 45-comb radial extractor. This turntable, as will be noted by the illustrations on pages 128 and 129, is placed midway between the uncapping machine and the Simplicity extractor. When the turntable is full of uncapped combs, they are lifted one by one from the turntable and placed in the extractor. While the latter is extracting the combs, the turntable is filled again from the uncapper in the same manner. Mr. Hiltner and others who use it claim it saves expense of an extra extractor, but the turntable costs almost as much as an extra extractor, and requires an extra handling of all the combs. For that reason the uncapping machine is placed midway between two extractors by some who prefer either two machines or more. As fast as the combs are uncapped they are put into the extractor which is not running. As soon as this is filled from the power uncapper, it is started up and the other machine is stopped when the combs are removed and put into supers. By this plan the combs are handled only once. In others words, they go direct from the power uncapping machine into one of the big machines standing temporarily idle. As soon as this extractor is filled, it is

Three Simplicities operated by T. E. Hodgins. Kincardine. Ont.

started and the other one is then emptied and the combs are put into supers.

Some uncap the combs and put them into supers piled up in front of the extractor with a pan underneath to catch the drip. The extra extractor has the ad-

A battery of two Simplicity extractors operated by a single belt with universal joint between the two machines.

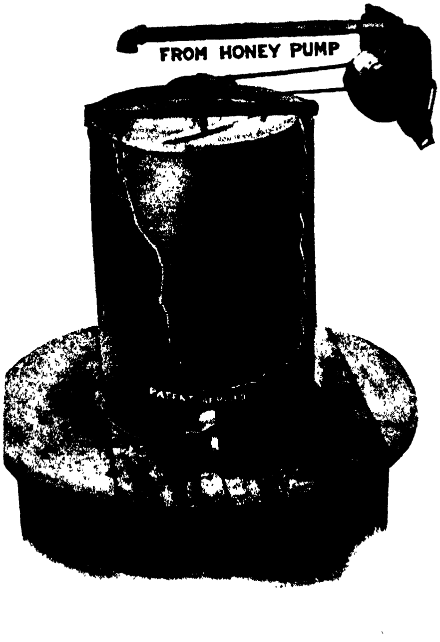
vantage that it is very handy to the one uncapping combs. It also saves one handling of the combs.

The two plans are here presented so that the large honey producer can make his choice. As shown on previous page two machines are placed in tandem and another cut shows three machines likewise placed.

The advantage of two power extractors is that they save time and labor. While the machines may be lying idle perhaps eleven months of the year, yet during the one month they are in operation they will save enough to more than pay for the labor employed, where hand or small machines are used.

Straining the Honey

The ordinary method of straining extracted honey is through common cheesecloth, but a relatively large surface of the cloth must be presented in order to do



Root centrifugal honey strainer strains the thickest honey rapidly.

the work satisfactorily. For that reason there should be a sort of framework about fourteen inches square and twelve inches deep to hold the cloth.

But the most rapid arrangement for straining the honey is the Simplicity extractor or a separate Centrifugal strainer. This, operated by a one-sixth or one-fourth horse-power motor, or from the line shaft driving the extractor, will do the work much more rapidly than anything that has ever been devised before. The bag does not clog up, and can be changed at noon or at night in three minutes. It operates like an extractor. In other words, centrifugal force drives the honey through the side of the screen onto the can and finally down to the honey-gate below. The machine, as will be seen, consists of a can and a perforated cylinder somewhat smaller and shorter than the can itself. This is pivoted at top and bottom, and on the inside is placed a bag of cheesecloth held in place by spring clothespins. This machine will take care of two Root Simplicity extractors operating at the same time.

The Gravity Method of Clarifying Honey

The settling tank method of clarifying honey is used by many large producers. The honey is pumped into tall tanks one after another, about 6 feet high. In a day or two, depending on the thickness, clear honey may be drawn from the bottom of the tanks.

A modification of this plan is successfully used by Lloyd Gardner. His four tall honey tanks are connected together by two-inch pipes. From the bottom of tank No. 1 the pipe goes directly to the bottom of tank No. 2, but inside the tank is an elbow turned up and a vertical piece of pipe extending up almost to the center of the tank. On the other side of tank No. 2 is likewise a two-inch pipe leading to the bottom of tank No. 3 and then on the inside up nearly half way. The fourth tank is similarly connected to No. 3. A gate valve is between each two tanks. By this plan the clearest honey is drawn from the bottom of each tank, the air and foreign matter rising to the top in every case. Clear honey may be drawn from the bottom of the fourth tank as fast as it runs into the first tank from two Simplicity extractors.

Automatic Devices for Ringing a Bell When a Can Is Full

In drawing honey from a tank into a 60-pound can it is a great convenience to have an automatic alarm that will give notice when the can is nearly full. Several beekeepers have gone still further and worked out ingenious devices to shut the gate on the tank automatically when the can is full. These are quite complicated, however, and unless one is a natural-born mechanic they are likely to be more of a bother than a help. A simple

alarm, on the other hand, is of practical benefit.

W. Z. Hutchinson used regular platform scales with the weight set at about 58 pounds exclusive of the weight of the can. When the beam rises, the electrical circuit is completed and the bell rings. The operator shuts the gate off at just the right time.

The bell is an ordinary doorbell, and the current is furnished by any dry battery. The method of making the connection is very simple. In brief, two wires run from the binding posts on the battery to those on the bell. One of them, however, is broken and one of the ends fastened to the scale beam at the pivot, and the other located just above the outside end of the beam.

It may be noted that when the can is full the scale beam rises and comes in contact with the copper wire just above it, and the bell rings. All the connections must be kept tight, and occasionally the end of the scale beam must be brightened with a bit of sandpaper, also the wire where it makes contact on the scale beam. Any corrosion at these points would result in failure of the bell to ring.

EXTRACTING-HOUSES. — See Buildings.

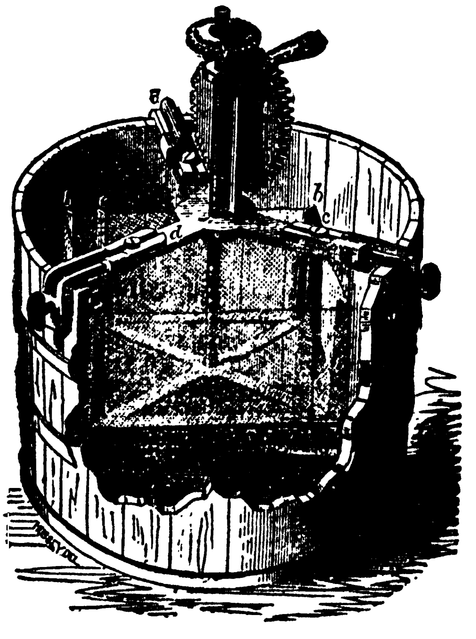
EXTRACTORS. — In the olden times the only method of securing honey in liquid form was to crush the combs in some kind of press and strain the honey through cheesecloth. Where there was some brood present in the combs the brood juices mingled with the honey, and the product obtained was called "strained honey" This term conveys the impression that the honey itself was separated, not only from the comb but from the dirt, pollen, dead bees, and brood. This was only too true in many cases. In most apiaries of the South where box-hive beekeeping is more or less prevalent, there is no liquid honey except such as has been strained from the crushed combs.

The modern extractor that takes the honey by means of centrifugal force not only saves the combs, which are worth from 35 to 75 cents each, and can be used over and over, but furnishes a product in point of quality and sanitation that is far superior to the strained honey of old.

First Extractors

In the year 1865 Major D. Hruschka, of Venice, accidentally discovered the principle which led to his invention of the extractor in that year. His little boy, while playing, was whirling a basket around his head by means of a short piece of rope. He happened to have a piece of honeycomb in the basket and the centrifugal force caused a few drops of honey to be thrown out into the air. His father grasped the principle, which led him to construct a rude machine that actually extracted the honey without crushing the combs.

Apparently Hruschka's discovery and invention did not attract attention in this country until 1867 when L. L. Langstroth, the inventor of the hive and frame bearing his name, built and successfully used an extractor geared back as in the modern machines of today, but instead of a metal can he used a wooden tub to hold the mechanism as shown in the cut below.

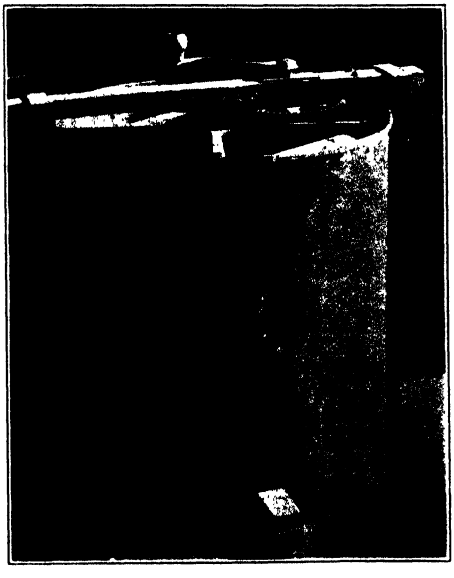


—From the American Bee Journal, 1868.

The first extractor built in the United States. Langstroth, the inventor of the hive and frame bearing his name, was the first to build a honey extractor in the United States. With his quick genius for the practical, he early saw the necessity for gearing to increase the speed of the reel.

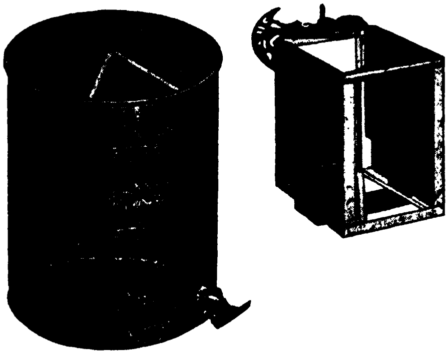
Langstroth's quick genius for the practical and useful in bee culture early saw the value of centrifugal force for removing honey from movable combs. Without his invention of movable combs the dis-

covery of Hruschka would have been of little value. The surprising thing was that Langstroth immediately used gearing to increase the speed of the reel holding the combs. A number of these machines were listed and sold by Langstroth & Son in 1867. The machine as shown on previous page was described by L. L. Langstroth in the old American Bee Journal, page 189, for 1868. In the same issue was an article by Moses M. Quinby on another subject. He may have gotten his idea from Langstroth. However that may be, Quinby, like Langstroth, was quick to see the value of this "honey slinging machine." In the same or subsequent year Quinby built a machine of his own. This is now on exhibition at the Langstroth-Root Memorial Library at Cornell University and is here shown. Quinby went one step further and put his reel and gear work in a metal can.



The original extractor made and used during his life by Moses Quinby. Note the heavy spur gears, the oak cross-bar, the oak framework underneath, forming a support for the lower bearing.

In 1868 A. I. Root constructed an all metal honey extractor using the gearing of an old apple paring machine mounted on a wooden cross arm to drive the reel. With this old machine he extracted 285 pounds with the help of an assistant in seven and a half hours. This for 1868 was considered a record breaking feat. He took in all 1,000 pounds of honey from 20 colonies and increased them to 35. In 1869 he took over 6000 pounds of honey from 48 colonies. A. I. Root did not keep his light under a bushel. He told the world about it. Then came a call for information as to how he did it, and immediately a demand



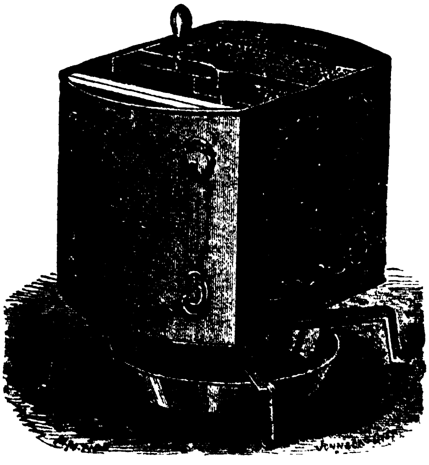
A. I. Root's first extractor.

sprang up for his machines. He sold literally thousands of them under the name of Novice Honey Extractor. One of these original models as he perfected it is shown here.

A. I. Root's improved Novice was so great an improvement over all that had preceded that it found a ready sale at once. The crank was geared so that one revolution made three revolutions of the combs. (See Extracting.)

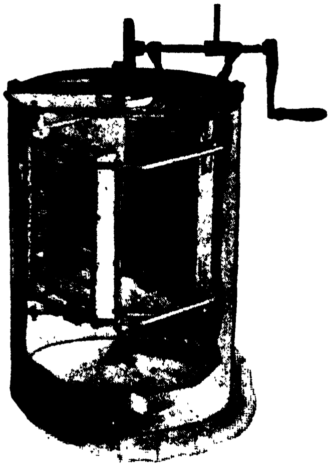
Reversible Extractor

When the honey from one side of the



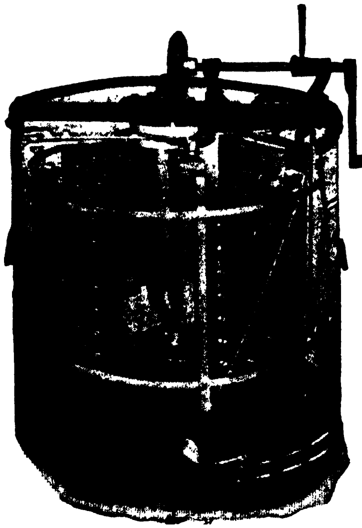
Peabody honey extractor. This is one of the early honey extractors built and sold in this country. This as will be noted had no gearing and the whole can revolved. Without gearing it could not do effective work.

combs was extracted in the Novice machine the combs had to be lifted out and turned around in order to throw the honey out of the other side.



Two-frame Cowan reversible extractor, with pockets hinged on inside.

About the time that A. I. Root was experimenting along this line Thomas William Cowan, then editor of the "British Bee Journal," constructed what was called the Cowan reversible extractor. Sev-

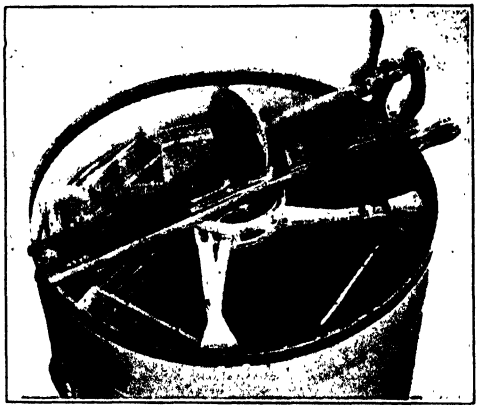


Four-frame multiple reversing extractor.

eral "baskets" holding the combs and hung on hinges like a door, could be swung from one side to the other, and either side of the comb could be next to the outside. The first side could be extracted, and then the basket swung around so that the honey could be thrown from the other side without taking out the comb and reversing it.

The Root Multiple Reversing Extractor

To reverse the Cowan extractor, it is necessary to stop the machine, and with the hand catch hold of the pockets and swing them around to the other position.



This shows the principle of reversing of the extractor. The pockets at the top and bottom are hinged on one side. The levers here shown connect each pocket with the reversing drum, which, when temporarily slowed down and then stopped, causes the levers to shift from one position to the other, reversing the pockets to the other position.

The multiple reversing extractor, as its name indicates, reverses the pockets simultaneously when the brake is applied. The lever acts as a brake until the extractor has been reduced in speed to a certain point, when the hub of the reel is held stationary by the brake, and the reel, which continues to turn, accomplishes the reversing of the pockets by means of the reversing levers located on the top of the reel. The strain of reversing is borne entirely by the brake, thus relieving the driving mechanism of all stress.

Central Pivot Reversing Extractor

All reversible honey-extractors on the market make use of one of two principles for changing the sides of the combs. The first one, that of baskets swinging from hinges on one side like a common door, has been used for the last 30 years, and it has given good satisfaction; but it has its limitations. The other one, perhaps just as old but newer in its application at one time attracted a great amount of favorable comment. In the older type the reversing is accomplished by swinging

the pockets on their hinges from one side clear over to the other. This principle necessitates the stopping of the machine, or nearly so, before the reversing can be accomplished. Even at slow speed the centrifugal force tends to throw the baskets over to the reverse side with a bang unless care is used. With new or tender combs, or combs not wired, there is more or less breakage, especially when careless help does the work.

In modern practice it is the almost universal custom to start throwing out most of the honey on one side at a comparatively slow speed to reduce the weight of the comb. It is then reversed, when the other side is extracted clean. The first side is then returned to its first position and extracted again. This makes two reversings, and each time the machine must be slowed down, or stopped and started again.

This is a top view looking down into the eight-frame Buckeye extractor, the pockets of which are reversed on a central pivot. As will be noted, it is perfectly easy to insert and remove the combs. The tops of the pockets are firmly held in place, no matter how severe a strain may be placed on them. The act of reversing is accomplished by means of sprocket wheels that are made integral with the pinions meshing with the internal gear or rims at the top of each pocket. Each of these sprockets is actuated by a chain driven from a sprocket mounted on a hollow shaft loosely journaled on the main shaft from which power is received.

In the other principle, although it is as old as the first, the baskets, instead of being hinged on the side and swinging like a door, are pivoted in the center. Of course, it is impossible to have a shaft go through the comb; but the basket can be pivoted at the top and bottom, thus in effect reverse the comb on its center line.

While it was admitted that this machine was more efficient than the one with the pockets hinged on the side, it was so much larger, heavier, and more expensive that it was finally taken off the market. Its extra size, weight, and cost just about offset the advantage of reversing at full speed.

Extracting Without Reversing

About 1920 new interest was revived in an old principle that had been exploited some fifty years ago by the author and by Hamet in 1867; see "L'Apiculteur" for that year; namely, the possibility of extracting the honey from the combs without reversing. The combs are placed with the end-bars pointing toward the center like the spokes of a wheel. The centrifugal force is applied along the midrib of the comb, thus causing a pressure toward the top-bar of the frame. Such a pressure forces the honey out of the cells on both sides of the comb at the same time. It then climbs over the surface till it reaches the top-bar, whence it flies to the side of the extractor. There are two ways of accomplishing this: (1) Placing the combs in a plane at right angles to the center of revolution; (2) placing the combs like the spokes of a wheel, the combs themselves being on a plane with revolving center shaft.

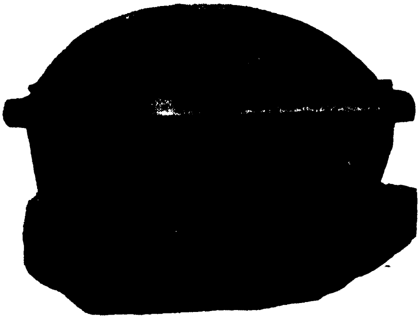


Fig. 1.—An early extractor in which the honey was extracted from both sides of the comb at the same time. From Gleanings in Bee Culture, September 1, 1888.

In the September issue of Gleanings in Bee Culture for 1888, page 773, the author illustrated and described the two methods. The first is shown in Figures 1 and 2, reproduced from that number of

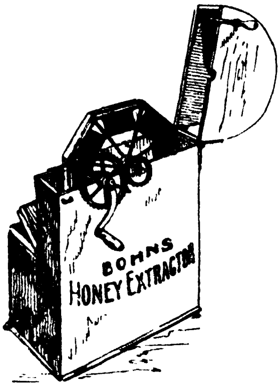


Fig. 2.—An early extractor similar to that shown in Fig. 1, except that the combs are whirled vertically. Reproduced from Gleanings in Bee Culture, November 1, 1893.

Gleanings, and the second is shown in Figure 3, also from that same journal. While the author did not try the principle as shown in Figures 1 and 2 he did try the one shown in Figure 3. He demonstrated at that time (1888) that it is perfectly possible to extract the honey from both sides of the comb at the same time without reversing, but it took from three to four times as long to get the honey out as when an equal number of combs were placed in a machine like those already described in these pages. At that

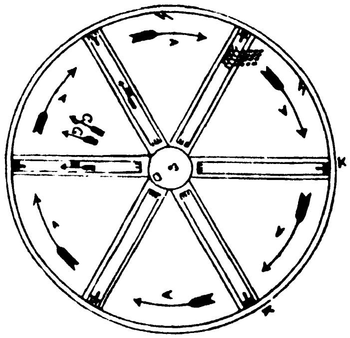


Fig. 3.—Diagram of radial extractor from Gleanings in Bee Culture, October 1, 1888. This is the principle of the extractor now receiving considerable attention in Europe.

time no attempt was made to increase the number of combs in order to offset the time limit. It would have done no good because this was long before the days of small electric motors or small gasoline engines. It was likewise before the days of commercial beekeeping, when small hand-driven extractors were quite able to do all the work of taking the honey. There were few or no outyards and of

Fig. 4.—General view of the Hodgson extracting plant. The upper half of the extractor can lifts up while the machine is being loaded and unloaded.

course very few beekeepers who produced honey on a large scale. The hand-driven machines requiring the reversal of the combs would take the honey out in from two and one-half to three minutes. The other principle, by which combs were arranged like the spokes of a wheel, required from eight to fifteen minutes to do the work. The idea was, therefore, abandoned as impracticable at that time.

The principle was revived in 1915 and 1916. See United States patent issued to Jacquet, No. 1,176,562, March 21, 1916. In 1916 M. Bernard in "L'Apiculteur" in the March and April issues, gives particulars of his bilateral extractor. See also in June, 1926, number of the same journal for a reproduction of the Bernard extractor. Another U. S. patent was granted G. S. Baird, No, 1,334,585, on March 23, 1920. Both of these show the principle in Figures 1 and 2, and not the idea shown in Figure 3. A French patent showing this (the radial principle) was issued to M. Sicot, No. 526,342, published October 1, 1921. The drawing shows something similar to the American 45-comb machine shown in Figures 5 and 6. The French Sicot patent and the descriptions of the same general principles of placing the combs radially as shown in Gleanings in Bee Culture for 1888 and in various European journals at that time antedate subsequent patents in the United States for a non-reversible extractor having the combs placed like the spokes of a wheel.

In 1921 Herr R. Reinarz, the editor of "Die Deutsche Biene," published details of his wheel extractor.

In view of the apparent interest in Europe in this principle of taking the honey from the combs, H. H. Root and Geo. S. Demuth in 1921 again tried out the plan, which could be put to the test very easily in the Buckeye extractor. The pockets were reversed to a point where the combs would stand like the spokes of a wheel. The principle was tested very carefully, using an electric motor to drive the machine. It was found that it would extract the honey, most of it, in about three minutes, but it would leave about two and one-half ounces of honey to the comb. Because of the residue, the idea was again given up for the time being.

A short time later, 1923, Arthur Hodgson of Jarvis, Ontario, Canada, tried the principle of extracting the honey as shown in Bohn's honey-extractor in Figure 2. He discovered that by running the machine longer, say from ten to fifteen minutes, all the honey could be taken. He then built a machine to take 48 combs, as shown in Figure 4.

To Mr. Arthur Hodgson and M. Sicot belong the credit of being the first to

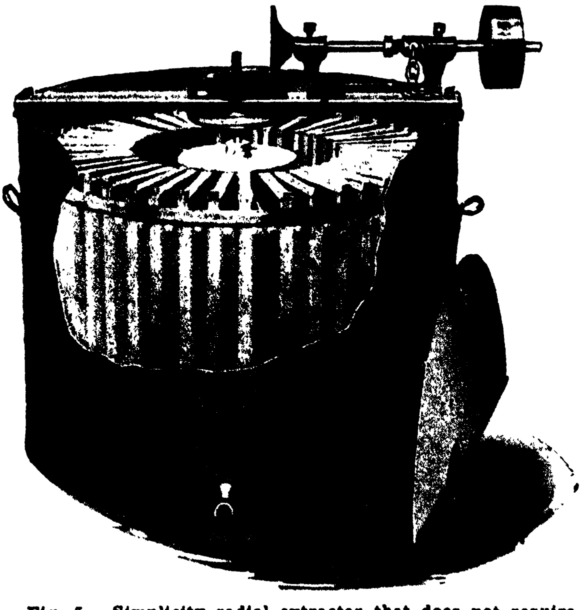


Fig. 5.—Simplicity radial extractor that does not require reversing.

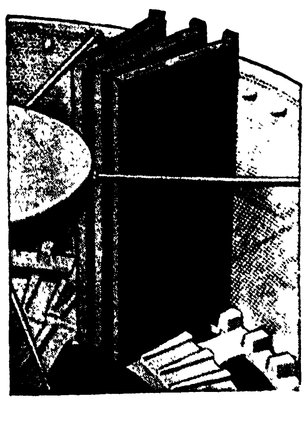


Fig. 6.—Detail showing how combs are placed in reel.

eliminate the time element by increasing the number of combs. Mr. Hodgson in 1923 built the first practical machine that would throw the honey out in a commercial way without reversing, and at the same time reduce the time limit per comb below the time usually taken per comb in the ordinary reversible 8-frame extractors.

Mr. H. H. Root, who witnessed an early test of the Hodgson machine in 1924, suggested that a cheaper machine holding a like number of combs could be built on the principle as used in our original machine as shown in Figure 3—that is, with the combs placed like the spokes of a wheel. A machine was built to take 45 combs and is shown in Figures 5 and 6. It was proven conclusively that this would extract the honey just as efficiently and thoroughly as the Hodgson machine at a much lower cost for the machine itself.

From the radial principle of extracting without reversing it might appear that one side of the comb would be cleaner than the other, on the theory that the cells preceding the direction of motion would not be as clean as those following the direction. Very extended experience, however, shows there is no difference. The combs are so close together that the air between them travels with them, with the result that there is no more pressure on one side than the other. (See Fig. 6.)

With either the Hodgson or the principle shown in the Simplicity extractor, the honey is thrown out on both sides of the cells simultaneously because the centrifugal force or pressure is in a straight line away from the center shaft through the center of the combs toward the circumference, or the can surrounding the revolving reel. This centrifugal pressure causes the honey to seek the top of the cells. It then climbs over the cells and finally strikes the can surrounding the revolving reel.

It will be clear that the part of the comb nearest to the center shaft will not have the same pull as that portion of the comb near the outer edge of the can. The combs should always be placed with the top-bar next to the outside and the bottom-bar nearest to the center shaft. Most of the honey in the comb will be near the top and the smallest amount will be near the bottom. But as the pull is the greatest near the top, the two parts of the comb will be emptied in about the same time, provided that the bottom of the comb is far enough way to receive sufficient centrifugal pull. It is clear that the radial principle can not be applied satisfactorily in a hand machine, because the bottom of the comb would be too close to the center shaft.

Advantages of the Non-reversible Extractor Over the Reversible Power Extractor

The 45-comb radial non-reversible extractor is superior to either of the 8-frame reversible extractors, as already described for the following reasons: (1) On the basis that the 8-frame extractor of the reversible type takes three minutes to extract a load, and that the big machine takes eight minutes to extract 45 combs, it will be seen that the latter does its work in just about half the time. Or, to put it another way, in a given time it extracts twice as many combs as can be handled in the 8-frame reversible. (2) While the 8-frame reversible requires the constant attention of one man, the big machine is so nearly automatic in the acceleration of its speed that it requires only about 12 minutes of time per hour. In other words, it takes only one-fifth of the labor of the smaller machine. With the little one it is necessary to extract partially one side, reverse, extract the other side, come back and extract from the first side. All of this takes time. With the big machine, after it is started no further attention is required on the part of the operator until the combs are ready to remove. It starts at a low speed, gradually increases automatically, throws out three-fourths of the honey at a low speed for about five minutes, then in about three or four minutes more it throws out the residue of the honey at a high speed. It does a cleaner and more thorough job with less breakage of the combs than is done with a power reversible extractor of the old type. During all this time the operator can do other work, such as uncapping, allowing the big machine to spin and finish the job. The only time required is to empty and refill it, start it, and then forget about it until the combs are extracted. (3) The big machine is very much easier on the combs if it is properly handled. If directions are carefully followed, most of the honey is extracted at a low speed. The speed automatically increases as the

honey flies out until high speed is reached. The pressure is all against the top-bar and not against the surface of the combs, as in the old type of machine. This means that scarcely a comb is broken, provided the frames are factory made, well nailed, and the combs wired in the frame. (4) The 45-comb non-reversible machine has twice the capacity with one-fifth the labor. (5) There is only one moving part—namely, the big reel—in the 45-comb machine, while in the reversible type there is not only the revolving reel, but the entire reversing mechanism, reversible pockets, reversing arms, and numerous other parts. (6) As explained under Extracting Honey, the non-reversible 45-comb machine will extract the honey out of the cappings at the end of the day's run, or at the noon hour if preferred. Removing the honey from the cappings by the old method of melting cappings and honey or that of draining is very slow and unsatisfactory. When the cappings and honey are melted, unless great care is taken the flavor of the honey after it is separated from the wax is impaired. In the case of the Simplicity extractor, or the centrifugal strainer, as described under Extracting, the honey comes from the cappings perfectly clear, and the cappings are almost dry. (7) A perforated metal cylinder surrounds the reel of the 45-comb machine. Broken pieces of comb, dead bees, etc., are caught on this screen, thus clarifying the honey to a large extent before it goes out at the honey gate. (8) As the comb surfaces during extracting do not come in contact with any part of the machine, the danger of spreading foulbrood is very much lessened. (9) It is much easier to get the combs out of a non-reversible machine because the pressure or force is against the top-bar that can not crush or stick to the reel. In the reversible machines, especially those using power, the pressure or force is against the surface of the comb. So great is it that new or soft combs are forced against and imbedded into the wire cloth or screen of the basket. When the frame is removed or reversed, there is danger that some of the comb surface will stick to the screen, with the result that the comb will be broken or defaced. This is not all—it makes it difficult to remove the comb. No such trouble occurs with the non-reversible radial.

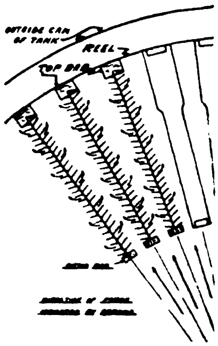
The advantages of the new method of taking the honey without reversing the combs are so patent that the large producers are adopting it everywhere and throwing out their old machines.

The Radial Principle Not Successful for Hand Extractors

The Simplicity 45-comb extractor owes its great efficiency and capacity to its size. An extractor on the radial principle holding eight or ten combs would be much slower per comb than a two or four frame extractor of the old type where the combs are reversed. Under conditions requiring 15 minutes to extract 45 combs in the Simplicity, three minutes would be needed to extract four combs in the reversible type machine. It follows that the average of the Simplicity is one comb in one-third of a minute, while the average of the four-frame machine of the old style is one comb in three-fourths of a minute.

How Both Sides of a Comb are Extracted at Once

Many do not understand why honey can be extracted from both sides at the same time without reversing. An examination of the arrows in the diagram above shows the direction of the force. If the top-bar of each frame is placed to the outside, the honey will come out of one side of the comb as well as the other, the upward tip of the cells favoring the flow



of the honey outward and toward the top-bar. The pressure should always be toward the top-bar, in order to clean all of the honey out of the combs. (The combs will also stand more pressure toward the top-bar than against an empty space between the bottom of the comb and the bottom-bar.) If there were pressure on the forward side, and a vacuum on the rear side, the honey should flow from the rear side of the comb more readily than from the other; but practical tests prove that one side of the comb is extracted

just as clean as the other. The air on both sides of the comb is moving with the combs, therefore the pull is in a direction outward from the center. This is known as the centrifugal force. It is exactly in line with the midrib of the comb toward the top-bar.

Power vs. Hand Machines

To determine exactly how much honey is left in the cells after extracting, the authors in 1921 made a number of tests with combs that for 2½ minutes had been in an eight-frame Buckeye extractor, speeded up to 350 revolutions per minute. Eight combs were carefully weighed before and after uncapping and extracting, then after these weights were secured the combs were cut out of the frames, melted up, and the honey, thus separated from the wax, was weighed and compared with the original amount of honey extracted from these eight combs. After several tests the amount of honey left in the cells was found to vary from 3 to 3½% of the original amount in the combs. These combs when taken from the extractor looked perfectly dry—that is, the exact angular shape of the base of each cell could be seen clearly. Where there is enough honey left in the cell so that the angles of the base all run together it is safe to assume that the percentage of honey left is very high, perhaps between 10 and 20 per cent.

In the small or hand-driven extractors the residue of honey left in the cells is much greater than in any of the power-driven machines, especially the power-driven 45-comb Simplicity. The reason for this is plain enough; the *hand-power* is not sufficient to maintain a high speed. One's hand or arm gets tired.

Friction Drive

The friction drive has been in use many years, and has been found the most satisfactory drive for a power honey extractor. It is not adapted, however, for a hand extractor, as the ratio of drive is about 1 to 1—that is, equal. The paper-rimmed pulley on the vertical shaft may be raised or lowered, thus changing the ratio of the speed; and while this is of great advantage in case the engine speed is not exactly right, or the size of the pulley is too large or too small, nevertheless it is not possible to "gear up" enough to drive the extractor by hand with a crank. In other words, it would be impossible to turn the crank fast enough to extract the honey sufficiently. For this reason some of the smaller producers who desire a large extractor, but who do not wish a gasoline engine, prefer the older beveled-gear drive, with the ratio of 2 to

Detail of friction-drive power multiple reversing gear bar. Central lever in horizontal position, which means that the reel is at rest. Raising this lever to vertical position engages friction disc with paper-rimmed pulley, causing the reel to revolve.

1—that is, one revolution of the crank-shaft means two revolutions of the reel.

Many beekeepers having less than 100 colonies use power outfits, but when the combs from more than 200 colonies are to be extracted a gasoline engine or an electric motor and a Simplicity extractor will almost pay for themselves in one season.

EXTRACTED OR COMB HONEY—WHICH?—Thus far there has been discussed the production of both comb and extracted honey. The question then will arise, which shall one produce?

When the honey-extractor first came into use, beekeepers quickly discovered that greater yields are secured when the combs are emptied and returned to the bees to be refilled than when the bees are compelled to build new comb each time. The honey-extractor was at that time heralded as a means of more than doubling the yield per colony, because after the combs were once built the bees were saved the work of further comb-building.

Later, when comb foundation was invented, it was thought that its use would be practically equivalent to the use of empty combs for surplus honey, and that this new product would enable the bees to store practically as much comb honey as extracted honey. In this beekeepers were disappointed, and it is now generally agreed that greater yields are secured when producing extracted honey. No agreement, however, has ever been reached as to just how much more extracted honey a colony will produce than comb honey.

Cost of Wax Production and Comb Building

In most of the discussions of this subject the difference in the yield for the two types of honey is attributed to the amount of honey that is consumed in the elaboration of wax for comb-building. Some of the earliest experiments in wax production indicated that 20 pounds of honey are consumed by the bees in the production of one pound of wax. For a long time this was accepted as the true figure.* Since comb sufficient to hold 100 pounds of honey contains from four to five pounds of wax, the bees, in secreting the wax necessary to build this amount of comb, would consume an additional 35 pounds of honey if the ratio of seven pounds of honey to one pound of wax is assumed to be correct—to say nothing of the time and energy used by the bees in secreting the wax and building the comb.

*Some later work showed that the ratio was between 6 and 7 pounds of honey to a pound of wax. (See Wax.)

Involuntary Wax-secretion

It is believed by many that a considerable amount of wax is secreted during a good honey flow whether it is needed or not, and some writers have contended that under certain conditions much of this wax is wasted if the bees are not given an opportunity to build comb. One of the first indications of the beginning of the honey flow is the appearance of new wax, used to elongate some of the cells in the upper part of the hive. Young bees, just before they become field workers, apparently secrete wax readily when they fill themselves with raw nectar, as they do during a good honey flow, and when combs are not needed. Even field bees often have tiny wax scales protruding from their wax pockets when caught as they are working on the flowers.

During more recent years many producers of extracted honey have been cutting deeper into the comb when uncapping. One object of this is the production of wax at but little cost, the theory being that the wax needed to elongate the cells when the combs are given back to the bees would otherwise be wasted during a heavy honey flow, especially in colonies having an abundance of young bees of comb-building age.

Under favorable conditions a few frames of foundation mixed with empty combs may be drawn out and filled with no perceptible reduction in the yield; but, if none but frames of foundation are given, the yield is usually considerably reduced. It is apparent that the difference in yield of the two types of honey can not be calculated from the number of pounds of honey needed to produce a pound of wax; and, conversely, the number of pounds of honey required to produce a pound of wax can not be computed from the difference in yield between the two types of honey.

Great Variation in Yield Under Different Conditions

During some seasons the character of the honey flow may be such that practically no comb honey is secured, while in the same locality a fair crop of extracted honey may be produced. Yet in the next season in the same locality the yield of

the two types of honey may be nearly equal. In some locations the character of the honey flow is such that the average yield of comb honey may be even less than one-half that of extracted honey, while in other locations the average yield of comb honey during a series of years may be 75 or 80 per cent of that of extracted honey; and, finally, under precisely the same conditions as to location and season the beekeeper without skill and experience in comb-honey production will secure less than half the yield in comb honey as compared with extracted honey, while the skilled comb-honey producer may secure nearly as much comb honey as extracted honey.

Undoubtedly, the extra amount of wax secretion necessary in comb-honey production is a factor in reducing the yield; but it is by no means the only one, and under some conditions it becomes of minor importance. The condition of the colonies, the character of the honey flow, and weather conditions may have greater influence on the difference in yield than the secretion of wax and comb-building.

At the close of the honey flow there is usually more honey and less brood in the brood-chamber when comb honey is produced. If there is no later honey flow, this additional honey in the brood-chamber must be considered when comparing the yield with colonies used for producing extracted honey. In addition to this, there are fewer bees to "board" during the late summer. On the other hand, if there is a later honey flow of considerable importance, the greater number of young bees in the colonies used for producing extracted honey may result in a great gain in surplus at the end of the season over those used for comb-honey production. The difference in yield in these cases can not be greatly influenced by wax secretion and comb-building.

Difference in the Spirit with Which Bees Work

Probably the greatest factor among the causes of the difference in yield of the two types of honey is in the difference in the spirit with which the bees work, and the rapidity with which they expand their activities throughout a large super space when empty combs are given in the supers instead of frames of foundation. It sometimes happens that conditions are such that the work of the colony becomes stagnant even during a good honey flow when comb honey is being produced; but this does not often happen when extracted honey is being produced, if sufficient room is given.

The problem of swarm-control is so closely associated with the spirit with which the bees work that it is difficult in some instances to separate these two things. Much of the loss in yield in comb-honey production comes about by some of the colonies being thrown out of condition for best work while preparing to swarm or because of some hitch in the management in the control of swarming. When it becomes necessary for the beekeeper to interfere to prevent the issuing of a swarm, the colony may respond to his treatment by a period of loafing, as if to get even with the "big boss" who presumes to meddle with its private affairs. Thus the skill of the comb-honey producer is sometimes taxed to the limit in controlling swarming and at the same time keeping the bees in the best working mood.

Since most of the conditions which tend to bring on swarming are the same conditions that tend to reduce the spirit with which the bees work, the beekeeper, who by careful management is able to stimulate his colony to work with the greatest possible vigor from the very beginning of the honey flow, not only increases his yield because of better work, but at the same time greatly reduces the tendency to swarm.

It sometimes appears that the spirit with which the bees work is of even greater importance in securing a large yield than the number of workers, and herein, to a great extent, is the key to successful comb-honey production. The beekeeper who can do these things, if located in a region suitable for comb-honey production, will probably produce about as many sections of comb honey per colony as pounds of extracted.

The beginner with one or two colonies, especially if he wishes to keep down his investment, better produce comb honey. His colonies will be in better shape for winter and he will save the cost of an extractor and the danger of starting robbing while extracting. His honey will be in marketable shape without any special containers.

On the other hand there is less swarming when producing extracted honey. Of

course, there is nothing to prevent the beginner from producing both comb and extracted honey.

No Demand for Comb Honey

As a final consideration there are some localities particularly in the South where there is no demand for comb honey in sections. Obviously there is no use in producing a product for which there is no market.

There are other localities where the honey comes in so slowly that the sections would be poorly filled out and the combs themselves would be travel-stained. Such a product would have little or no sale.

Still again there are localities where only dark honey is produced and much of it is of poor quality. Such honey should never be put in sections. The only dark comb honey of marketable value is buckwheat. The capping of this is very white, which with the strong rich flavor makes buckwheat comb honey a good seller.

As a final conclusion no one should attempt to produce comb honey unless the honey flow is fast, the colonies strong and the honey light colored and of good flavor. All other honey should be extracted and put in the proper containers. (See Extracted Honey.)

EYES OF BEES.—Bees have two sets of eyes—three small or simple eyes, located in the top of the forehead, and two compound eyes, located on each side of the head, each eye consisting of many units. (See page 27.) In drones the number of these units is much larger than in the queen or the workers.

The exact purpose or function of these two sets of eyes is not definitely known. Some have held that the three simple eyes are for field or long-distance work and that the two large compound eyes are for close-up work. Others have held the exact opposite. The fact that both sets of eyes are fixed, or immovable, and the further fact that the separate units in the compound eyes are so numerous and at all angles, lend support to the view that the compound eyes do the field or long-distance seeing.

It seems to be pretty generally agreed that the vision of the bees, except perhaps for distance work, is not sharp or clear. They will detect moving objects much better than those that are still.

It is likewise agreed that bees recognize color in a way that most other insects do not. It is their job to hunt for food among flowers of many colors. It is probable that color as well as odor play an important part in their selection of the flowers they visit. (See Color Sense, page 71.)

For further particulars see the book, "Beekeeping," by Dr. E. F. Phillips, of Cornell University, who has made a special study of the eyes of the bee.

F

FADS AND FANCIES IN BEEKEEPING.—See Mistakes in Beekeeping.

FAIRS, EXHIBITS AT. —See Honey Exhibits.

FARMER BEEKEEPERS.—Sometimes the professional class of honey-producers have a feeling of antipathy, if not disgust, toward the farmer who keeps a few bees, especially if he is in the immediate neighborhood. In some cases, at least, there is some justification for that feeling. Some farmers have too many irons in the fire. They do a little of everything to make a little money, but they do nothing particularly well.

A farmer of this class usually has hard luck. His buildings are in a tumble-down condition, machinery out in the weather, his fences down, his stock ill fed, and, on top of it all, he is in debt. When he keeps bees he allows them to take care of themselves, his swarms get away from him, hives are robbed out, and if weakened by disease, foulbrood is scattered far and wide. He does not take any agricultural paper, much less a bee journal, and sells his honey at any old price.

He never gets any honey unless the season is extraordinary. It is no wonder that the real progressive beekeeper finds such a farmer a menace to his business.

Fortunately, the majority of our farmers are well-read, comfortably well off, and if they keep bees they secure fair returns from them. There is nothing that will yield for him larger returns for the money invested than bees. His wife and children can get a little money on the side by keeping bees as by keeping chickens; and the chances are two to one that they will make more money, and at the same time keep the home supplied with the most delicious sweet that the world has ever known. Such farmers are adding dignity and strength to their calling; and when they keep bees they get a better crop of seed from their clover; more and better fruit from their orchards (see Fruit Blossoms and Pollination); plenty of honey for the family, and a little extra clean cash.

It is not an uncommon thing for a few hives on the farm to bring in a net return of five or even ten dollars per colony.

Of course it is only fair to say that in some years the bees on the farm will not do much; but it is a poor farmer beekeeper who can not make the bees pay their own way during poor seasons, and even make handsome returns when the season is good. The farmer who has an orchard and raises alsike, sweet clover, alfalfa, or vetch, will be able to keep his few colonies more than busy.

Every up-to-date farmer, especially if he raises clover seed or fruit, should keep bees. See Fruit Blossoms; Back-lot Beekeeping; Bees and Fruit-growing; Bees and Poultry; A B C of Beekeeping.

FEEDING AND FEEDERS.—Feeding is practiced for two purposes—to prevent starvation, and to stimulate brood-rearing at times of the year when no honey is coming in from natural sources. These will be referred to later under separate heads. Whenever possible, feeding should be avoided; for at best it is a messy job, expensive, and, in the case of the beginner, liable to cause robbing. In a locality with honey flows in the fall it should be possible to avoid feeding altogether. To buy sugar by the barrel every fall is very expensive, and the beekeeper should lay his plans to avoid it as far as possible. In many instances fall feeding is made necessary by extracting too closely, even from the brood-nest. This is bad practice and decidedly poor economy. Natural stores go farther, pound for pound, than sugar syrup. Where there are no fall flowers it is advisable to use the food-chamber. (See Food-chamber.) But there are times when it is necessary to give the bees food either to keep up and stimulate brood-rearing or to prevent actual starvation.

It is always poor practice to extract good honey out of the brood-nest. While at times the natural stores might bring twice as much as the same weight of sugar syrup, the labor of extracting and the wear and tear of the colony itself in feeding and evaporating the syrup are so great that no economy is effected. Ordinary sugar stores should be supplied only to make up the deficiency, if any.

When the honey already in the hives in autumn is of good quality, and nicely sealed, it would be folly to extract it, put it on the market, buy sugar, make syrup, and feed it to the bees. There would be very little gained by it, even if the honey sold at a higher price, and the sugar syrup were cheaper. Where the natural stores are dark, of poor quality, or bad honeydew, it might be advisable to extract and put in their place sugar syrup. Yet of late years it is coming more and more to be the practice to let the bees have natural food of their own gathering, provided it is nicely ripened and sealed in the comb, no matter what the source; and it is very seldom that any one will lose bees in outdoor wintering by reason of poor food.

Where one does not have combs of nice stores sealed or food-chambers containing good honey reserved from the crop (see Food-chambers), it will be necessary to feed cane or beet sugar syrup. The cheapest and best food for this purpose is ordinary white granulated sugar. Some of the brown sugars may be used; but experience has shown that they are not so good, and not so cheap in the end, although selling at a lower price. Moreover, they contain gums that are not a good feed for the bees. Corn sugar or glucose should never be used. The former will granulate solidly in the combs from the syrup and the latter the bees can not and will not take.

Granulated sugar syrup, when capped over, makes an excellent food for winter. It does not cause dysentery, and is cheap; but it is not the equal of good honey for breeding, as it is lacking in some of the necessary food elements in honey. (See

Food-chamber.) On the other hand, sugar syrup is, perhaps, a little better as a food during the coldest part of the winter in the North. It is less stimulating—that is, less inclined to start up premature breeding in winter or very early spring.

In midwinter, if the bees are short of food, they should be given a comb of sealed honey laid on top of the frames, or candy made of granulated sugar. (See Candy for Bees.)

If combs of sealed stores are not to be had, it is advisable to give cakes of candy, as described under Candy for Bees. By reserving a half-depth or a full-depth super of natural stores from the crop it will seldom be necessary to feed. (See Food-chambers.)

How to Make the Syrup

Something will depend on whether the bees are to be fed for the purpose of inducing brood-rearing or to give a supply for winter. For stimulating, a syrup made of one part of sugar to two of water by bulk is about right. If the water is hot the sugar will dissolve more readily. For a winter food given early in the fall the proportion should be about two parts of sugar to one of water. For late feeding, just before cold weather comes on, the ratio should be about two and one-half to one. When made as thick as this the syrup is liable to go back to sugar to some extent. It is advisable to put in about a teaspoonful of tartaric acid to every 20 pounds of sugar. Others find it better to use honey. The proportion of honey should be about one-third by bulk of the amount of water used. If honey is used care should be taken to see that it comes from hives where there has never been any foulbrood.

A syrup made by mixing two parts of water to one of sugar, or equal parts of both, does not necessarily require heat. The water may be poured into a receptacle cold, and sugar stirred in until the requisite quantity is reached. The stirring will have to be continued until the sugar is all dissolved. If there is any quantity to be mixed in that way, an ordinary hand-driven honey-extractor serves as a very excellent agitator. The machine is filled nearly half-full of water, when the sugar is poured in little by little while the reel is being turned. It will have to be revolved until the sugar is all dissolved. After a vigorous turning of the crank, even after the sugar is thoroughly mixed, there will be a number of small air-bubbles. These will all disappear if the syrup is allowed to stand for a while. When the proportion of the sugar is two to one or two and a half to one, it is advisable to use hot or boiling water.

Syrup can be mixed in a common wash-boiler where heat is employed. In that case the boiler is put on the stove and filled with the requisite quantity of water. After it has come to a boil, the sugar is slowly stirred in, a little at a time. While on the stove the mixture must be kept thoroughly stirred to prevent the undissolved sugar from settling on the bottom and burning. Care should be taken, because burnt sugar or syrup is liable to be fatal to the bees.

In many cases syrup has to be prepared at the outyard. Or perhaps the housewife objects to having her stove mussed up. While an oil or gasoline stove will heat the water, either one is very slow. Some use and recommend a good-sized common galvanized washtub, such as can be obtained at any hardware store at a comparatively low price. This is placed outdoors on four or five stones of suitable size. The right proportion of water is poured into the tub. A fire is then built under it, and when the water comes to a boil the granulated sugar is slowly stirred in. After it is all dissolved the fire should be scraped out from under the tub to prevent overheating or burning. This work should be done on a cool or rainy day when the bees are not flying; otherwise robbing may be started.

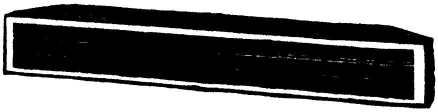
Feeders

There have been hundreds of feeders invented and put on the market. Some of them are very complicated, and the more so the less useful. If one desires to keep down his investment he may use common tin pans. These can be placed in the upper story of the hive and filled with syrup. On top of the syrup should be laid a strip of cheesecloth that has been dampened in water. The bees will crawl up on the cloth and get the syrup without danger of drowning. After the feed is all taken, the cloth is likely to be stuck down by the dried crystals. Boiling water, however, will very soon clean it.

A feeder that has been used very largely is the Simplicity trough feeder. It is an excellent feeder, cheap in price, and occupies very little room on top of the brood-frames; or it may be used in front

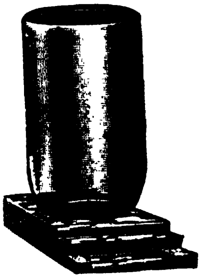
of the entrance at night when the weather is warm. It should not, of course, be placed there during the day on account of the danger of robbing.

Another feeder that has been used very



Simplicity feeder.

largely consists of a common wooden butter-dish, or pie-plate, such as one gets at the grocery when he buys butter. A hundred of these can be nested together so as to take but very little room, and the price is insignificant. It is not necessary to use cheesecloth with the butter-dish.



Boardman entrance feeder.

Pepper-box feeder.

Set it on the top of the frames, and fill it with syrup.

Feeders on the Atmospheric Principle

The practice of giving chickens water on the atmospheric principle has been applied to feeders for bees. A common Mason jar, filled with syrup, and covered with a common saucer, when inverted will make a very good feeder for bees. But in order to provide for a proper flow, three or four toothpicks should be put between the jar and the saucer. At this time the saucer will be right side up, and the jar upside down. As fast as the bees take out the syrup air will enter the jar, and syrup will flow into the saucer.

The device is rather crude and unhandy. A better atmospheric feeder may be made out of a Mason jar and cap in this way. Break and remove the porcelain in the top of the cap, and then punch two or three holes about the size of a common pin. Fill the jar full of syrup, screw on the cap, and invert. In that position it must be held by some contrivance where it will be secure from robbers and the bees can go under and take the syrup through the above-mentioned perforations.

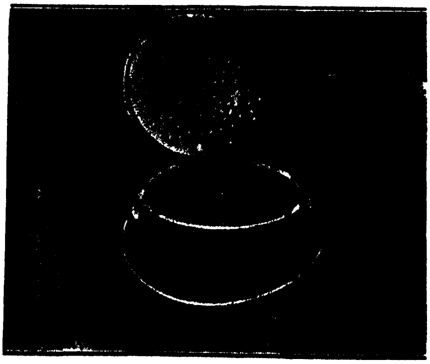
Manufacturers make a special Mason jar-cap with perforations; and with this cap they supply a block of wood bored to receive a Mason jar when inverted. This will hold the jar ⅜ of an inch above the bottom of the hole in the block. Through the bottom is a mortise or slot that communicates with the entrance of the hive when the feeder is attached to the hive. This is accomplished by inserting the projection into the entrance.

This does not require the opening of the hive, and, what is of some importance, permits the apiarist to see at a glance by looking down a row of hives what feeders are empty or nearly so. One can take a wheelbarrow load of filled cans, lift the empty ones out of the blocks, and substitute filled ones. It is the work of but a few minutes to supply every colony in the apiary with a filled can of syrup. This is especially convenient during a dearth of honey when it is desired to keep up brood-rearing for increase. For further particulars regarding this feeder, see Feeding to Stimulate.

The pepper-box feeder is another form of atmospheric feeder that has been advertised quite extensively. While this can be inserted into an entrance block like the Boardman, it is not so easy to determine when it is empty. Ordinarily it is used in an upper story or super above the brood-chamber.

Friction-top Pail Feeder

Perhaps about as handy a feeder as



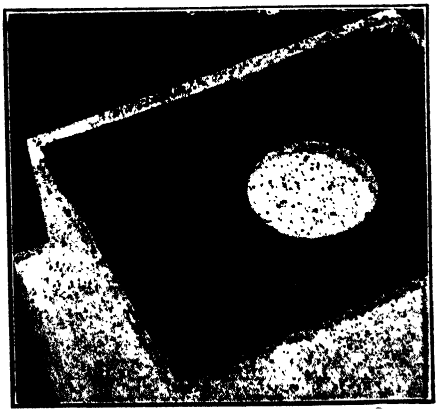
The 5 and 10 pound friction-top pails that are used so largely make the simplest and best kind of feeders for supplying winter stores. Punch the lid full of very fine holes, fill with syrup about two parts of sugar to one of water (warm if weather is cool), and crowd the lid down tightly and invert over the frames.

any, certainly the cheapest, is the 5 or 10 pound friction-top tin pail, which has been coming into favor during recent years. The lid is punctured with about 20 to 30 holes made with a three-penny wire nail.

The feeders are filled with a syrup, 2 or 2½ parts of sugar to one of water, the

Invert the pail over the hole in the escape-board directly above the cluster in the brood-chamber. There is plenty of space to permit the bees to work over the whole surface of the lid.

density depending upon the lateness of the season. In cold weather the syrup should be quite thick and warm. Over the colony to be fed, an empty super is placed, and one of these pails of syrup inverted immediately over the cluster



Or, dispense with the escape-board altogether and put the pail directly on the top-bars of the brood-frames. Cover all around with an old sack. The syrup can not run out any faster than the bees take it.

and covered with an old sack to prevent the heat of the cluster from escaping above. Some strong colonies will take the contents of a ten-pound pail in a day. If not taken as rapidly as it should be, the residue of the cold feed should be removed and replaced by warm syrup.

Feeding to Stimulate Brood-rearing

As previously intimated, feeding to stimulate brood-rearing is a very different proposition from feeding to supply the bees with the necessary winter stores. In the case of the former it is desired to get a large force of *bees* (not stores) for the approaching harvest or the approaching winter, the method of procedure being the same in either case. To stimulate brood-rearing, approximately half a pint of syrup daily should be fed; but if that amount be given in an ordinary open feeder the bees will take it all up in about an hour's time. The result, if the syrup is given in the morning, or even during the middle hours of the day, is to excite the colony unduly. Bees will rush out into the open air to ascertain where the sudden supply of food may be obtained. If a whole apiary is fed in this way, there is a general uproar of excitement, often followed by robbing of some of the weaker colonies and nuclei, for the bees in the field will pry into everything. An entrance unguarded is immediately attacked; and unless there is sufficient force to repel the onslaught, robbing will get so far under way that it may cause the robbing-out of the attacked colony. But this is not all. When the supply of syrup in the feeders fails, bees are apt to be cross, sometimes attacking passers-by or stock in the fields. This is particularly so if robbing gets started. For these reasons it is usually advisable to feed toward night.

Happily it is possible to avoid all this trouble by using a feeder that will make a quart or a pint of syrup last during the entire 24 hours of the day. In the case of a nucleus, the amount can be so regulated as to last 36 or 48 hours.

When the supply of food comes in very slowly, about as it would come in from a very moderate honey flow, enough to give the bees and queen encouragement to keep up brood-rearing, they will rear more brood than if the supply is intermittent. All excitement—that is, uproar in the air—as well as robbing is avoided. It is impossible to fix the ordinary open or pan feeders so that they will not give out the syrup too fast; but it is possible to regulate the friction-top, pepper-box, and Boardman entrance feeders. This is ac-

complished by using lids having but three or four holes or perforations.

For stimulating, this slow feeding is a great convenience, because one can give his bees a supply of food to keep up the normal functions of the colony for two or three days. For very slow feeding one hole is better than more. A strong colony will require more openings than a weak one; and in all cases syrup for stimulating should be in the proportion of about two parts water to one part of sugar, thoroughly stirred until the sugar is dissolved.

Perhaps the reader does not own any friction-top, pepper-box, or Boardman feeders, and yet would like to practice slow feeding as herein directed. All he needs to do is to procure a quantity of self-sealing tin cans that can be readily obtained at the ordinary grocery store. Through the top punch a hole just large enough to admit a common pin. If this hole does not prove large enough to let out sufficient food, two holes may be used, or even three, depending upon the size of the colony. This can should then be filled with syrup, and the top pushed firmly in place.

Experiments have shown that this scheme of slow feeding will raise more brood for the sugar used than where the same amount is given intermittently in open feeders. The author prefers the Boardman entrance-feeder because it is possible to see at a glance through the glass when the syrup has been used up. If the supply has been taken, it is very easy to put a filled can in the place of the empty one without disturbing the hive or the bees.

By turning to Food-chambers it will be found that it is coming to be more and more the practice to give a half-depth or a full-depth super of natural stores to a colony in the fall. This saves the time of feeding and is just as cheap. It automatically provides room for the queen to lay eggs in the spring. It means better colonies.

Feeding for Winter

But if colonies must be fed sugar syrup mainly, the general practice is to feed some time in September, in the northern tier of states. Still, in many localities in central United States, there is warm weather in October sufficient to start brood-rearing, and much of the stores fed in September may be consumed so that what is left is not sufficient to last until the new honey flow. For this reason it is often unsafe to feed in September and give no further attention to the bees.

But before we begin the actual work of feeding we make a preliminary canvass of the whole apiary. This we do by "hefting" each hive; that is, we lift up either the front or back of the hive. A little practice will enable one to determine approximately the amount of stores in each hive, provided there is not too large a force of bees. In that event, we must allow for a corresponding increase in the amount of syrup given. As we go over each hive, we mark on the cover with a piece of chalk the number of pounds that will be required. If the colony is a strong one, we allow for a total of 30 or 40 pounds, if it is to be wintered outdoors; or, if indoors, about two-thirds that amount. We aim to have each colony strong enough so that it will require an average of about 30 pounds each for outdoor wintering in addition to the natural stores. After all the hives are marked we proceed to the actual work of feeding.

For this late fall feeding there is no better feeder than the ten-pound friction-top pail previously described. It holds ten pounds, so that if one wishes to give a colony a large feed at one time, two or more feeders must be given the colony. It can be quickly put on or taken off without much disturbance to the brood-nest. During the season, any combs that are too old, or which, for some reason or other, are not perfect, whether due to drone-cells or irregularities, can be gradually pushed to the outside of the brood-frames; then in the fall, when it is time to put in the feeder, these defective combs can be very easily taken out to be melted up later, and with no loss of brood. If the colonies need feeding, these outside combs will not contain much honey. On a cool day an outyard can be looked over very quickly, and the old combs that are on the outside of the brood-nest removed with very little trouble.

The best time of day for putting feed into the feeder is toward the close of the afternoon. It is not advisable to do the work in the morning or early in the day, for the reason that the bees become excited, and robbing might be started, especially if it were warm enough for the

bees to fly. Right here is a point in favor of the chilly-weather feeding, for there is no such danger of robbing, of course, when the bees can not fly on account of the cool temperature.

It is the usual practice to prepare the feed at home and carry it to the yards hot in the 10-pound feeder pails, right side up with the perforated top. A hundred or more of these pails can be carried at a time in a light auto truck. On arrival at the yard the pails of hot syrup are inverted and set on the combs. There should be, of course, an upper story to receive the pail or pails.

Feeding in Freezing Weather

Although colonies have been wintered well when fed after cold or freezing weather, much the safer plan is to have it all done not later than October, for the northern states, that they may have the syrup ripened and entirely sealed. If the weather is not too cold, one can feed with the friction-top feeder as previously intimated. If one has been so careless as to defer feeding until cold weather sets in, frames of sealed honey or a food-chamber should be given if they are available; if not, candy is given. (See Candy.)

If hot syrup is covered with cushions or something equivalent, it may be fed at any time, although it does not seem to be as satisfactory under all circumstances as a food-chamber.

Feeding in the Spring, or Feeding Enough in the Fall to Last Till the Next Honey Flow

Some years ago it was the general practice to feed in the spring to stimulate brood-rearing, such feeding taking place as soon as settled warm weather came on. The purpose of this was to get a large force of young bees for the coming harvest; but in later years the practice on the part of our best beekeepers has been toward feeding enough in the fall to last not only all winter but during the spring and until the honey flow, or, better yet, give a super of natural stores as recommnded under Food-chamber. Experience shows that spring feeding very often does more harm than good by over-stimulation. Brood is expanded beyond the capacity of the bees to cover and keep warm. Robbing is often induced. Beginners especially are apt to overdo it; and even a veteran will some times get his colonies so strong before an extra supply of nectar comes in that swarming will be brought on prematurely.

Feeding at Night or During a Rain When Robbers Are Bad

During a dearth of honey, when robbers are bad, especially in hot climates, colonies can be fed during a light rain, or at night if it is a case of emergency. When the rain is over, or as soon as daylight comes, the feed will, in all probability, be taken up, and all excitement in the hive be over. When feeding at night, a lantern can be used; but it should be placed some little distance from the hive where feed is being given. A small pocket flashlamp can be used advantageously to place the feeders and to pour the syrup, after which, to prevent attracting bees, the light should be cut off.

In warm or tropical climates it is never advisable to feed during the day if there is a dearth of honey, as it is liable to stir up the whole apiary, resulting in serious robbing and the destruction of some of the weaker colonies.

As a matter of fact, feeding at all times should be avoided, if possible. It should be considered only as a necessary evil, as a rule. Natural stores in the form of combs of honey or a food-chamber are much superior to sugar syrup, except during cold weather when there is no brood-rearing.

Feeding Causes Loss of Bees

Some experimental work on the part of the author goes to show that feeding causes a considerable loss of bees. Feeding always causes excitement, during which the members of the colony will rush out into the open air to find the source of the sudden supply of sweets. As feeding is wholly artificial, the instincts of the bees prompt them to jump to the conclusion that the dancing bees (see Bee Behavior) have found a copious supply of nectar, and out they go to get it. If the weather is at all chilly at the time, many bees are lost.

Even if the weather be warm there is considerable loss after each feeding, especially when feeding a large amount for winter. The bees gorge, and neither man nor beast can eat fast or gorge without injury. A big supply of syrup has to pass through the organism of the bee before it is finally inverted or ripened and deposited in the cells. This puts an unexpected and sudden strain upon the digestive tract. It is well known that common

syrup is a straight sucrose. But after it has been passed through the bees' stomach it is partially changed into an invert sugar of nearly equal parts of dextrose and levulose.

The author noted on his lecture trips that bees fed either honey or syrup at night, and confined to their hive until about 11 o'clock the next day, would show considerable loss of bees in the bottom. Caution was always taken not to daub the bees, but invariably the day after feeding it was noted that there would be a loss of several hundred bees in a nucleus of about ten thousand bees. On the other hand, when the entrances are open continuously during the entire twenty-four hours, as they are in an ordinary bee-yard, those bees that are in distress as a result of gorging will fly out and drop on the ground, with the result that their presence or absence would not be noted as in the case of bees that could not get out.

All this would seem to show that the method of giving winter supplies in the form of sealed stores is much more economical of bee life. (See Food-chamber.)

FEEDING BACK.—The practice of feeding back a diluted honey after the close of the season to complete unfinished sections left over, was much more common in former years than it is today when emphasis is put upon the importance of stronger colonies and giving fewer sections and then forcing the bees to complete work begun *before* the honey flow is over. As there are some who may be caught by a large number of unfinished sections because they did not forecast when the season would close, some information should be given.

J. E. Hand, of Birmingham, Ohio, made a thorough study of this subject, and he learned that, while the work can be profitably done, much attention must be given to the details, since there are many things to take into consideration.

Many fail, he says, because they select the wrong time of the year. It is best to begin right after the main honey flow has ceased before the work in the supers is over, and use fresh honey the day it is extracted. At this time the bees naturally go right on as though the flow had not stopped. It is best to give about six quarts of thinned-down honey to each colony every other day. The interval between the feedings allows the bees time to remove the honey from the brood-nest, where it is first placed, to the supers. No definite rule can be given for thinning the honey, since the density varies so much. For average honey enough water must be added so that the syrup will be 75 per cent honey and 25 per cent water. Very thick honey needs more water, while thin honey needs less.

It is necessary to have the brood-chamber well occupied by brood, for bees never do well in supers over brood-chambers containing much capped honey. The first requisite is a good queen, which will be able to keep up egg laying against any amount of feeding. The brood-chamber must be contracted, so that the queen will be able to keep every comb filled with brood. It is quite important, however, to have the combs in the brood-chamber as new as possible, for the bees are quite apt to carry up bits of comb to be used in capping cells in the supers, and old dark comb will discolor the super-cappings to quite an extent.

The thinned honey should be put into the feeder just before sundown, so that there may be no uproar that may cause robbing. It is not desirable to have more than two supers of sections on the fed colonies at a time. As soon as the combs in the super next the brood-chamber are nearly capped, this super should be raised up and the upper one placed under it next to the brood-chamber. When the top super is finished and capped solid to the wood, it may be removed and a fresh super placed next to the brood-chamber. Of course it is not essential that combs be built out and capped solid to the wood. The combs all capped over, except cells next to the wood, would grade No. 1.

Caution: Fed-back Comb Honey Liable to Granulate

Under Comb Honey, to Produce, subhead, Bait Sections, reference is made to the fact that bait sections or fed-back comb honey is more liable to granulate than ordinary comb honey. Dealers have complained that the former granulates very rapidly on their hands; and when they know it they will not accept it unless for immediate sale. It should be sold in one's own locality, and sold as early as possible. While not all of it will granulate the history of such honey is unfavorable.

FEEDING OUTDOORS.—After what has been said elsewhere in this work re-

garding the danger of exposing sweets in the open air during the robbing season it may seem the height of folly to recommend what appears to be the same thing that has been condemned; but, as will be shown, this outside feeding may be practiced without the bad results. It is well known that, when bees are busy in the field in a natural honey flow, hives can be opened without any robbing. If the bees can be kept busy by making them go after food set outdoors, that is of the consistency of raw nectar, much the same result will be artificially accomplished.

But proceeding farther the question may be asked, "Why feed outdoors at all if the proper stimulation can be given by placing the food inside the hives that need it, rather than supplying all colonies alike, irrespective of whether they need stores or not?"

While it is much better to feed each individual colony according to its needs, there are times when one can feed a whole apiary by placing a weak syrup in an outdoor feeder. At any time when robbers interfere with the manipulations of the colonies, sweetened water outdoors diverts the meddlers by making a sort of artificial honey flow. When the bees can gather anything from the fields they are not disposed to rob. In the same way if the bees can be kept busy artificially, much the same results can be accomplished. This can be done with an outdoor feeder and sweetened water, as explained farther on. If one engages in queen-rearing, or desires to extract when bees will ordinarily rob, an outdoor feeder can be started so that the necessary work can be performed easily and secure from pilfering bees.

Outdoor feeding can also be employed to advantage to "call the bees off" when robbing the neighbors' preserves during the canning season. The same calling-off process can be used when the bees are robbing candy-stands or stands where lemonade or cut melons are on display for sale.

Within a quarter of a mile of the author's home yard there is a fairground, and sometimes it is necessary, if bees are inclined to rob, to start outdoor feeding the day before the fair opens, and keep it up during the fair. If there is a severe dearth at the time, bees are inclined to meddle with the candy-stands and soda-fountains. While the amount they actually steal is insignificant, their presence "drives away trade."

How to Feed Outdoors

While an expert may be able to set out unfinished sections for bees to clean, as spoken of under the head of Comb Honey, to Produce, subhead, Unfinished Sections, the practice on the part of the beginner should be discouraged. But one can feed outdoors without stirring up an uproar by feeding a *very thin* syrup, about nine parts of water to one of sugar. As already explained, this is virtually sweetened water. At the beginning a little stronger syrup will have to be made in order to start the bees. Then it can be weakened down to a nine-to-one basis.

In the way of feeders, two or three common washtubs can be used, but the surface of the sweetened water should be covered with sticks or corncobs to prevent the bees from drowning; and there should not be much more than an inch of liquid in the tubs, or at least not more than will be required to supply the bees all day or as long as it is desired to keep them busy. If the sweetened water is left out over night during warm weather, it is liable to sour, so that a supply greater than the bees can take up for the day should never be given.

To prevent the bees from crowding, use a large surface; hence it is recommended to use two or three tubs with an inch of sweetened water in each rather than one tub with three inches of liquid. When the surface is comparatively small, the bees crowd each other in a way that is injurious to their wings; and by spreading the feed no bee will be compelled to crowd against its neighbor.

Disadvantages of Outdoor Feeding

Having said this much in favor of outdoor feeding of a whole apiary, it should be clearly and emphatically stated that it is an expensive way of feeding bees. When a colony can take the syrup from an ordinary feeder, either at the entrance or on top of the hive, and place it in the combs, the wear and tear on the bees is nothing as compared with that which takes place when the bees are compelled to leave the hives, fly to the feeder, scuffle with each other, and then rush back in pell-mell haste to their hives to unload.

One year, when robbing was very bad, and when it was desired to keep on with our queen-rearing operations, the bees

were fed for several weeks in outdoor feeders. It was very noticeable that the field bees had their wings badly worn, and at the end of the queen-rearing operations the fielders were conspicuous by their absence, and only young bees were left.

While outdoor feeding stimulates brood-rearing, it does so at a great cost. Besides the wear and tear on the wings themselves, there is the labor of reducing a nine-to-one sugar syrup or sweetened water (nine parts of water to one of sugar) to a well-ripened sugar syrup of two and one-half parts of sugar to one of water. When feeding in the hive, the syrup should never be weaker than one part of sugar to two of water, and it is often two and a half parts of sugar to one of water. It will be readily seen that outdoor feeding of bees involves an enormous drain on the colony.

There are also other serious drawbacks to outdoor feeding. It feeds all the bees in the vicinity, the neighbors' included, and might perhaps be instrumental in the spread of foulbrood. It also causes a disproportionate amount of syrup to be given. The strong ones will have much more than their share, and the weak ones considerably less. By feeding within the hive, one can regulate the supply for each colony or nucleus.

FENCE.—See Comb Honey.

FERTILE WORKERS.—See Laying Workers.

FERTILIZATION OF FLOWERS BY BEES.—See Pollination.

FERTILIZATION OF QUEENS BY ARTIFICIAL MEANS.—For years investigators (4) had attempted to accomplish the insemination of queen bees artificially before Watson (2) in 1926 became the first to demonstrate convincingly that such a feat can be accomplished. He succeeded only after patient and diligent application to the problem.

In order to understand thoroughly Watson's method it is necessary to realize that when mating takes place in nature, which is always on the wing, parts of the drone's genital organs are inserted within the genital opening of the queen in such a way that the sperm, after being discharged, is immediately followed by a mucus solution (1). The mucus soon hardens upon exposure to air and thus forms a sort of stopper to prevent the sperm flowing out of the genital opening. The mucus is later absorbed or ejected from the queen and so does not normally remain to form an obstruction to the passage of eggs.

Since in the bulb of the penis of a drone the sperm and the mucus are readily distinguished by the eye Watson was able, by aid of a delicate microsyringe of about 0.5 mm. bore, to take up from the bulb into the syringe first some mucus and then some sperm. On emptying the syringe by injecting the contents in the genital opening of a queen, the sperm is forced out first and the mucus last so that a mucus plug could be formed as in nature. However, later work has shown that a special effort to put mucus in the syringe is not essential for successful results. In Watson's method as originally described (7), the queen is tied to a small angle-shaped operating board in such a way that the tip of her abdomen is in position to receive the syringe. A micro-manipulator is employed to hold the syringe so it can be accurately and gently directed into the genital opening. In order to facilitate the entrance of the syringe the abdominal tips and the sting of the queen are kept back by a pair of finely pointed forceps held by hand.

Modifications of Watson's method developed at the Bee Culture Laboratory, Washington, D. C., have simplified the technique and made possible an increased output (4). Among other features, the queen is held in a small glass tube, and the abdominal tips are kept apart by two special hooks attached to the same stage as the micro-manipulator.

Although the Watson method of artificially inseminating queens does not yet give one hundred per cent results it is successful enough to utilize in studying heredity in the honeybee. Its present development even warrants the scientist to undertake the improvement of our present races of bees.

A more natural method of approaching the problem was used by Quinn (6). In 1927 he with the aid of his grandson, Harry H. Laidlaw, gave a demonstration of his method, commonly known as "hand-mating," before a meeting of the Louisiana State Beekeepers' Association in New Orleans. The method consists of holding the queen by hand, or otherwise, in such a manner that the drone's genital organs may be caused to evert into proper position in relation to the genital opening of

the queen when pressure is applied on the abdomen of the drone by hand. When this occurs the drone is cut loose from the queen, leaving part of the drone organs adhering to the queen, so that the queen thus treated appears very much as she would in nature after returning from a mating flight. In early demonstrations the abdominal tips of the queen were held apart by the points of a fine pair of protractors mounted on a fixed support.

In recent years Laidlaw has continued work with this method at the Southern States Station of the Bee Culture Laboratory. He (3) now uses a microscope in performing the operation, a glass tube for holding the queen, and a small spring for holding her abdominal tips apart.

A method in which the drone genital organs are first severed from the drone and then by the aid of a microscope are placed in the proper position in relation to the genital opening of the queen for insemination to be accomplished was developed in 1927 by Prell of Germany (5). Prell's work was indepndent of that by Malyschev of Russia, who reported success by a somewhat similar method in 1924.

The artificial insemination of queen bees gives every promise of being of service in commercial queen-rearing in the near future for the conservation of choice breeding stock. For the production of utility queens, however, there is little prospect that the commercial queen rearer will soon be able to give up his reliance on natural matings.

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FIGWORT (*Scrophularia marilandica.*) —See "Honey Plants of North America."

FIRE BLIGHT.—Fire blight causes the greatest damage on cultivated varieties of apples, pears and quinces. It has also been found destructive in nursery stock and other varieties of plants. This bacterial disease causes the greatest damage to leaves, blossoms, fruits and twigs of the tree. Burrill first discovered fire blight in 1877 and a year later announced that the disease was caused by bacteria. Trevisan in 1889 named it *Bacillus amylovorus* because of the short rod forms of the bacteria. This bacterial disease winters in the "hold-over" cankers. Waite showed that during the winter period the pathogene is in a more or less inactive state along the margin of the lesion of the cankers. During the spring period, the bacteria multiply rapidly and spread to the adjoining healthy tissues. A sticky viscous material oozes from the infected areas and serves as the source of the inoculum. According to the observations of various investigators the primary infections in the orchard from this inoculum may be disseminated in the orchard in many ways such as *wind*, *water*, and *insecis.*

Dissemination of the Fire Blight Organism

The importance of wind as an agent in the distribution of fire blight has received considerable thought. While Clark presents no evidence, he believes that the wind was the carrying agent of the disease in the orchard under his observation. More recently, Stevens, Ruth, and Spooner have shown that blossoms and twigs protected from insect visits were blighted as much as blossoms and twigs unprotected from visitations by insects. The following is quoted from their paper: "The only tenable hypothesis is that wind was the chief agent of transmission."

Meteoric water, or splashing raindrops, may often be responsible for the dissemination of the bacteria according to the experimental evidences advanced by various investigators. Gossard and Walton state that 50 to 90 per cent, and sometimes more, of all blossom infection is due to infected rain drip and not to contaminated insects as hereto supposed. Miller points out that the mode of dissemination of the primary inoculum from hold-over cankers to the blossoms and other susceptible parts has not been clearly demonstrated. The results of the three years of experimental work in Wisconsin show that meteoric rain is entirely responsible for the dissemination of the primary inoculum, that is, the distribution of the organism from the hold-over cankers, and also appears to be responsible for the dissemination of the secondary

inoculum which has reference largely to the dissemination of the organism from one blossom to another blossom. However, Pierstorff states that under New York conditions meteoric water did not appear to spread the blight bacteria from blossom to blossom. Tullis concludes that rain drip is one of the most important agents concerned in the spread of fire blight in Michigan.

Insect transmission of the fire blight organism has been shown by Jones, Stewart and Leonard, and others. Insects having sucking and biting mouth parts as leafhoppers, aphids, tarnished plant bugs, flies, beetles and probably others, disseminate the disease to various susceptible parts of the plant prior to and after blossoming. Pollinating insects of which the honeybee is most important, have been accused of spreading the fire blight organism. Evidence obtained from experiments shows that honeybees are not responsible for the dissemination of the primary inoculum from the hold-over cankers to the blossoms and that other sources must be attributed to the spread of the organism. Jones has observed flies, beetles, aphids and other Hemiptera feeding upon or walking over the gummy exudate from cankers. He furthermore states that he has never observed a honeybee on the gummy material. During three seasons Miller has never observed pollinating insects feeding upon or in contact with the exudate even though he has spent many hours watching exuding cankers. However, it can not be denied that pollinating insects including the honeybee are one of the sources of distribution of fire blight during the blossoming period.

But how important a role do the honeybees play in the distribution of this disease? Undoubtedly the honeybee as a carrier has been over-emphasized. Experiments where a tree has been enclosed in a cage, the blossoms heavily inoculated with a virulent suspension of the organism, and a hive of bees then placed in the cage demonstrated the maximum dissemination of the disease under laboratory conditions. There are obviously two reasons why under natural field conditions the dissemination of the disease would not be as widespread as in the evidence presented by investigators. First, blossoms would never contain the amount of fire blight inoculum as when the blossoms are artificially smeared with a large amount of the organism. Second, there could never be the intense bee activity within orchards as when the entire pollinating activity of a colony is concentrated on the blossoms of a single tree.

Bee Hives Not a Factor in the Spread of Fire Blight

Gossard and Walton were unable to isolate fire blight from hives in early spring and therefore concluded that the organism did not exist in the hive at the opening of the season. In 1931 Rosen caused a great deal of dissension among beekeepers and fruit growers when he published a paper stating that infected bee hives were responsible for at least a part of the current season's blight. Pierstorff of the Ohio State University, among the leading authorities on fire blight, has conducted extensive experiments on this pertinent question. The results of his studies are most significant. He demonstrated that it was absolutely impossible for bees to carry fire blight from the hive to blossoms even though the bee hives had been heavily infested with virulent cultures of the fire blight organism. Furthermore, he was unable to recover the fire blight organism from the frames, comb or honey, twenty-four hours after the hives had been heavily inoculated with a virulent suspension of the organism. From these infested hives the organism could not be recovered from the heads of the honeybees after two days, nor was it possible to demonstrate the presence of the organism inoculated in pure honey after the 11th day. Another outstanding practical contribution to fruit growers and beekeepers is the conclusive evidence that this investigator presents showing that the moving of colonies of bees from one location to another is not a factor in the spread of fire blight even though the colonies had previously worked on bloom or trees badly infected with blossom blight. Thus the bee hive is not a factor in the dissemination of fire blight under Ohio conditions.

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FIREWEED.—See Willow-herb.

FIXED FRAMES.—See Frames, Self-spacing.

FLIGHT OF BEES.—The distance bees go in quest of stores varies very greatly according to conditions. Usually on level country, more or less wooded, they do not go over one and one-half miles. If, however, there is a dearth of pasturage within that distance, and plenty of it along some river bank three to five miles away, they may or may not go that far. When bees go out after stores they evidently try to find their nectar as near the hive as possible. They will not go over half a mile if they can get a sufficient supply within that distance; but in most cases that range does not supply enough pasturage, and it is evident they keep increasing their flight until they go as far as one and one-half miles. If they are unable to secure enough, and if there is forage on beyond, they often go farther.

Bees will sometimes fly over a body of water or a valley from an elevation three or even five miles, particularly if there are fields in sight that are somewhat showy. Whether they have a long-range vision or not has not been proven; but the fact that they will find white patches of buckwheat five miles away across a valley is somewhat significant. In a like manner they will go across a valley four or five miles to orange bloom in California. Whether they are guided by sight or smell in either case is difficult to prove; but it is quite probable that a breeze will carry the odors of a buckwheat field or of an orange grove in full bloom to bees five miles away. While we might not be able to detect odors at such a distance, the scent organs of the bees are much more acute than ours; and they might and probably would get a knowledge of its presence in a given locality.

As a general rule, as stated at the outset, bees do not fly much over one and one-half miles. Where they have to go greater distances their wings sometimes show wear, especially if they have to pass through shrubbery.

The author once had one yard located in an aster district. The supply of nectar gave out in the nearby fields; but some of the bees of that yard were traced to asters five miles away. That fall there was a very rapid loss of bees. Colonies that were strong just before the asters came into bloom dwindled to three or two frame nuclei. The surviving bees had their wings badly frayed. The presumption is that in dodging through and over shrubbery in their long flights they tore their wings more or less, with the result that large numbers of them never got back home.

When bees are going to and from the field, they fly as low as possible to avoid the wind. Instead of flying over shrubbery they will dodge through it for forage on the other side. At other times they will fly over it. The author has observed, however, at one of our yards, that bees would go no farther than a piece of woods half a mile away. The probabilities are that, on rising to the height of the trees, they encountered a current of wind in the opposite direction. It is a well-known fact that bees can not fly against a strong wind.

The Range of Flight and Its Relation to Outyards

In the location of outyards one should take into consideration the general lay of the land and the character of possible bee-forage. In ordinary white clover regions where there are patches of woods, buildings, or much shrubbery, bees do not fly much over one and one-half miles; but when clover ceases to yield, and basswood can be found two or three miles away, those same bees will fly farther; and when conditions are right, they will fly from three to five miles, and even seven miles across a body of water. But locations that furnish such long ranges are very rare.

The flight of bees will determine somewhat the size of the beeyard. If they do not go farther than one and one-half miles, probably not more than 50 colonies

can be kept in the location, and possibly 30 would be better.

In some parts of the country as many as 500 colonies can be kept in one place. Mr. E. W. Alexander once kept 500 colonies at Delanson, N. Y, on a hill overlooking a valley. He traced his bees five miles from home many times, and secured large crops of honey. J. F. McIntyre, at his Sespe apiary near Ventura, California, kept over 500 colonies. In both of these cases it is evident that the bees would have to fly at least five miles in order to get the proper yield per colony. When an apiary of 50 colonies secures a good yield, the presumption is that the bees do not fly very far; and it sometimes happens that 30 colonies will do better than 50. In that case they should be located about three miles apart, making a radius of flight of one and one-half miles.

Government Experiments on Flight Range of Bees

Some very interesting observations were made on the flight range of the honeybee by Dr. John E. Eckert, associate apiculturist of the Division of Bee Cuture in the Bureau of Entomology, U. S. Department of Agriculture. The work was done during the summers of 1927, 1928, 1929 and 1930 in Wyoming and Colorado, where conditions would be favorable for measuring the flight range of bees over desert areas, and in irrigated sections, where there was an abundance of sweet clover and alfalfa at varying distances from the bee yards.

The first observations were made on the flight of bees from colonies located on a prairie during a dearth of nectar when an artificial source was provided. In the second series observations were made on colonies located in a stretch of badlands lying between two irrigated districts supporting good growths of sweet clover and alfalfa, and in the third, experiments were conducted with apiaries located within sweet clover territory.

The results of these interesting series of experiments are recorded in a reprint of 32 pages from the "Journal of Agricultural Research," Vol. 47, No. 5, for the year 1933. Numerous tables accompanied with a detailed explanation show what was observed under the three conditions named. As it would be impossible to publish this whole paper an excellent summary of the work is here given:

Summary

Estimates of various writers have placed the flight range of honeybees at distances of from 1 to 7 or more miles, but little experimental evidence has been presented. It is also generally believed by beekeepers that bees will fly in all directions from an apiary in quest of nectar and pollen. Regulations governing the location of apiaries in respect to the control of bee diseases, from the viewpoint of honey production, and to prevent bees from becoming nuisances, vary widely in their requirements owing to differences in the assumed distances that bees can fly.

When colonies were located on a prairie in Wyoming, during a dearth of nectar, it was found that the bees would fly but 1.5 miles for artificial stores and at least 3 miles for pollen and nectar.

When bees were separated from a given nectar-producing area by the badlands, with no other source of food intervening, they flew a maximum distance of at least 8.5 miles. Colonies located within 0.5 to 2 miles of a given source of nectar made gains in weight, over a period of 3 years, as great as, or greater than, similar colonies located within the same nectar-producing area, and colonies lost in weight when placed 5 miles or more from nectar.

When colonies were moved for varying distances up to 3.5 miles, many bees went to the fields and then returned to their former locations. The return of such bees was undoubtedly influenced by the fact that the colonies had been moved into surroundings that were similar to their former locations and also by the fact that the bees worked in the same territory in which they had worked before being moved.

Experiments on the distribution of bees from apiaries located within a nectar-producing area showed that bees have a tendency to fly in only one or two major lanes of flight, neglecting similar forage plants in other directions. Bees would fly for 2.75 to 4.6 miles in one direction when located within a nectar-producing area and confine their efforts to working in that direction rather than in nearer fields of seemingly equal attractiveness. In one series of observations, bees were found to work most numerously in fields located within 0.5 mile of their apiary. Where several apiaries were located within the same general territory, the major lanes of flight from the different apiaries did not indicate so much trespassing of the bees from any one apiary on the territory of another as might be expected from the proximity of their locations. Where the nectar supply was limited, bees from several colonies in each of five apiaries worked in the same small field, some of the bees flying at least 2.5 miles to reach the field in question.

The results confirmed the conclusions of previous investigators that bees have a tendency to return to the same portion of a field, or to the same small field, on successive days for nectar and pollen, even though other areas of the same forage plant are nearer.

While in the main, the findings of Eckert confirm the statements that have stood for several editions of this work, there are some variations. For example, Eckert finds that while bees will fly over prairie only one and a half miles for artificial stores, they will go three miles for pollen and nectar. On the other hand, the author of this work found that on wooded land in the East bees would seldom go further than one-half mile for clover. The reason for this doubtless was that enough pasturage within the distance was found

within the one-half-mile radius without going further. During a scarcity he found that bees would go much further even on wooded land. There is here no real conflict of opinion.

It is rather interesting to note that even in prairie country Eckert learned that bees "have a tendency to fly only in one or two major lanes of flight." The author in the East has repeatedly noticed that bees will go in one certain direction out of the yard but had believed that the direction taken, was one of convenience to avoid buildings or trees. Apparently there is another inexplainable reason for this.

Eckert also finds that bees will sometimes pass over near-by pasturage for that which is more remote. This might be explained on the ground that the latter was better than the former or that it furnished the first nectar supply and that the bees continued to go to that pasture even though nearer was available later on.

The author's observations on this point covering a series of years in the East show that bees will seek the nearest bee range first and that when this is nearly or entirely exhausted, they will go further. This opinion is supported by other writers.

The conditions referred to by Eckert were rather unusual and should not be taken as normal for the most of the country.

This whole question of flight range of bees has an important practical bearing in the location and distance of bee yards from each other on account of foulbrood and in the outlying bee pasturage.

FOOD-CHAMBER.—This is the most important development in bee culture in modern times. It is the key that unlocks the door to success. Around it revolve many of the manipulations described in this work. It is not only a great labor-saver, but it goes a long way toward insurance against winter loss and against failure of the crop.

What is a food-chamber and why is it so important? Briefly stated, it is a super or hive-body filled with combs of natural stores, the best honey of the season. This super of honey is not extracted, but is held in reserve from the crop until after the main honey flow, when it is placed back on the hive, either then or in the fall, to save the cost of sugar and the labor of feeding, to promote better wintering, and to increase the crop next season. Feeding sugar syrup is an expensive proposition at best. Converting sugar into sealed stores entails a large amount of labor and material and, worse than all, a severe drain upon the vitality of the bees in reducing the syrup to a suitable food for winter. Sugar stores, unlike good ripe honey, contain no minerals, proteins, vitamins, or other substances so necessary to brood-rearing in the following spring.

At one time it was believed that sugar syrup made the best food for the entire winter and the following spring. While it is admitted that the syrup answers a most excellent purpose during the cold part of the winter, when there is no brood-rearing, later opinion is almost unanimous that the best honey stores sealed in the combs are better for all-around wintering and spring management. It stands to reason that an artificial food can not be equal to the food supplied by nature in the first place.

In addition to the loss from feeding an artificial food, there is the cost of extracting the honey that is already nicely sealed in the combs; the cost of containers and then finding a market for the honey after it is taken off, and the cost of feeding. The food-chamber principle saves all of these items. When the food-chamber is used, both fall and spring feeding are eliminated; and, should the spring be late and cold, so that the bees could get no natural stores, the reserve of sealed honey in the food-chamber tides the bees over until the time when honey does come in. During all this time there is no need to even look at the hives to see if they are short of stores.

There is hardly a more costly mistake in bee culture than to let colonies in the breeding season run low on honey. It is a serious mistake to let them run low in late summer or early fall and then give big feeds of sugar syrup. This food comes too late to provide young bees so necessary for good wintering. The food chamber takes care of all this.

The food-chamber idea is not adapted to the large hive like the Jumbo (see Hives.) The trouble is that the bees will form a rim of honey above the brood, and that rim of honey is apt to deter the bees from going into the supers when the honey flow begins. When the hive units are

smaller this troublesome rim of honey can be put under control. For example, when a food-chamber is put on a hive of Langstroth dimensions the brood in the lower story (if the cells are not stretched) will reach up to the top-bars. When the supers are put on, the honey will be put where it is wanted. (See Demaree Plan of Swarm Control.)

Again, the food-chamber is not a scheme to increase the size of the brood-nest so much as it is one to put the brood and honey where they are wanted. While on the hive it is an automatic feeder, so that the bees will not curtail brood-rearing when most needed.

The Tremendous Saving in the Food-Chamber

The two main advantages in using the food-chamber are the tremendous saving in labor connected with apiary management, and the assurance of strong colonies of bees ready for the main honey flow. Each beekeeper should know his own locality and adopt a method of food-chamber management that best suits his needs. The following quotation is from an article which appeared recently in one of the bee journals: "Whenever a beekeeper decides to reserve a full-depth super completely filled with well-ripened honey for each colony going into winter quarters, a new beekeeper is born."

How to Use the Food-Chamber

The food-chamber hive lends itself naturally to different methods of manipulation during the main honey flow. There are at least four methods.

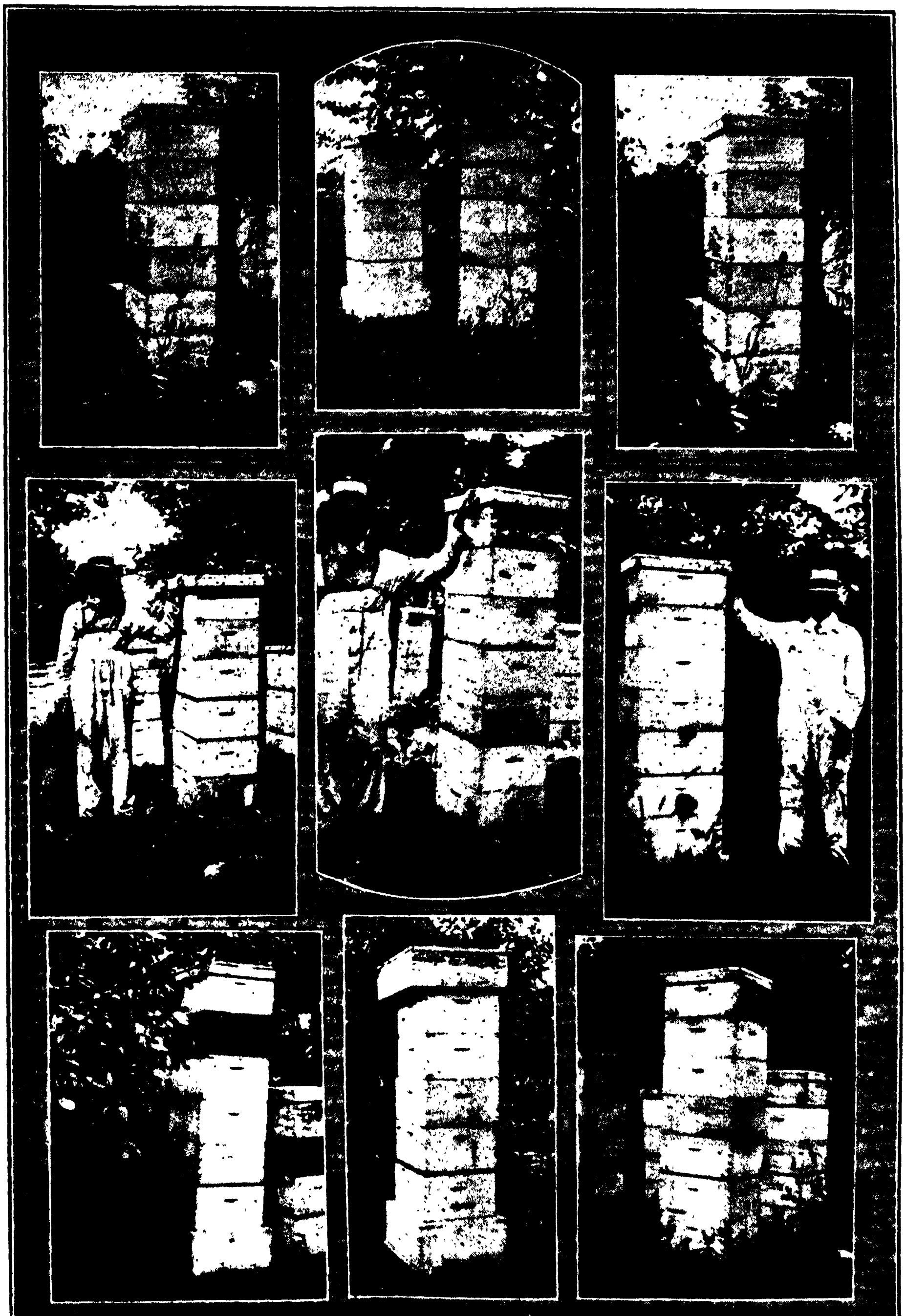
METHOD NO 1. The surest way to get the food-chamber jammed full of honey is to place it above an excluder during the main honey flow and keep it either on top of the pile of supers or somewhere among them. This, of course, necessitates considerable lifting of the food-chamber during the honey flow. When we first began using the food-chamber we kept it on the top of the pile. This method seems to be preferable where there is a honey flow of comparatively short duration, as, for example, in some alsike and white clover localities where there is little if any sweet clover and no fall honey flow of any consequence.

METHOD NO. 2.—This method consists of leaving the food-chamber directly on top of the brood-chamber during the honey flow, in fact during the entire year, thus giving the queen access to two sets of combs. The queen-excluder is placed directly on top of the food-chamber, and supers are added as needed. This method would hardly be applicable to comb-honey production. This manipulation of the food-chamber, which is by far the simplest, seems adapted to sweet-clover localities where the flow is long drawn out and tapers off gradually toward its close.

At the beginning of the major honey flow there is, as a rule, considerable brood in the food-chamber. As the honey flow continues and this brood emerges, the combs in the upper story are filled with honey and the queen is crowded down into the lower chamber. This is exactly as it should be, because we want the upper chamber filled with honey at the close of the major honey flow.

METHOD NO. 3.—This method is also recommended for localities that give a long drawn-out honey flow. It is especially adapted to the production of comb honey. When the main honey flow starts and at the time the first supers are given, the food-chambers are removed. When full-depth food-chambers are used, it is usually necessary to sort out enough combs that have the most brood to fill the lower chamber which chamber is left on the old stand. The chamber containing the remaining combs is then placed on a new hive stand or on a weak colony. These food-chambers, as they are removed, can be stacked up five or six high. At the close of the season they will usually be found to be filled with honey. In fact, the pile of supers contains a rousing colony. Later, after all of the surplus honey has been removed from the original hives, these chambers of honey are placed back on the hives from which they were taken.

METHOD NO. 4.—In this method also the food-chamber is removed during the major honey flow, and it is recommended only for localities that give a honey flow of considerable duration. When the main honey flow starts and just before supers are put on, remove the food-chamber (which at that time should contain considerable honey, also some brood) to a hive stand placed close to and facing the same direction as the parent colony. Be sure the queen is left in the parent colony. The food-chamber is soon depleted of its old bees which return to the parent stand, but the young bees remain. A ripe queen-cell should then be given to this division. In due time, a young queen



The practical results from the use of the food chamber is here shown in pictures from different apiaries of the author's. These yards are run on the principle of long-range beekeeping. With so large amount of stores, the bees need only to have supers given on a few trips. At the end of the season the supers are hauled home and extracted.

will be mated and laying. She will not be permitted to do much laying because honey will be crowded around the brood-nest. The hive is primarily for food not brood. If no queen cell is given, this division will rear a young queen since it has some young brood.

At the close of the main honey flow, when the surplus honey is removed from the parent colony, the food-chamber containing the young queen, is placed back on the original colony. When uniting is done during October, after brood-rearing has ceased, there is usually no fighting. It has been demonstrated that the young queen is the one that survives in the majority of instances. With this management of the food chamber, automatic requeening as well as providing ample food for the colony is accomplished at one stroke. In the production of extracted honey, this method obviates handling the food-chamber while supering during the

The proof of the pudding is in the eating. Lots of brood previous to the main honey flow enables such colonies to store good surplus even during ordinary seasons.

honey flow. Then, too, when the two colonies are united in the fall, the resulting colony is very strong in bees, with a young queen, both of which are major requirements for successful wintering. This method is especially well adapted to the production of comb honey.

In buckwheat and goldenrod regions objection has been made to the food-chamber, because some of the dark honey in the food-chamber gets mixed in with the clover honey the following season. When the food-chamber is well filled with white honey instead of dark honey, this does not happen. So this is another reason why the food-chamber should be filled early in the season with well-ripened honey, preferably white honey, of good quality.

Best Size of Food-Chamber

In regions where there is practically no fall honey flow, the full-depth food-chamber is preferable. In localities where there is a dependable fall honey flow, the shallow extracting super is usually large enough. The full-depth food-chamber is growing in favor for two reasons: it is more likely to contain an ample amount of stores and the frames in the food-chamber are interchangeable with the frames in the brood-chamber.

In some regions where the major honey flow comes in the fall, the use of the food-chamber may not seem to be advisable. This is especially true where the late honey flow is long and the bees practically fill the brood-chamber with honey. However, even in such localities, it may be best to reserve at least a shallow food-chamber of honey for each colony.

In the far North, where cellar wintering is practiced and where thick sugar syrup is fed late in the fall, the food-chamber would be rather cumbersome. It can, however, be reserved to be put on after bees are put on their summer stands in the spring.

History of the Food-Chamber

In 1905, 1906, and 1907 G. M. Doolittle, of Borodino, New York, was working out a plan for the production of comb honey and at the same time eliminating swarming. As it was practically impossible for him, owing to the condition of the roads, to make frequent trips to his outyards both in the fall and in the spring, he decided that he would eliminate all feeding by reserving combs of buckwheat honey from the previous fall. These he set aside in supers. When he went to the outyards, on the first trip he gave the bees one or more of these combs of honey if they needed it. After the colonies were built up in strength he made another visit to the yard and placed on top of the brood-chambers a queen-excluder, and above that a super containing eight

combs of buckwheat honey. This was virtually a food-chamber designed to take care of the bees between the time of dandelion and fruit bloom, until white clover honey began to come in. If honey came in, it was added to the supply of stores above. This upper story, Mr. Doolittle called at the time his "storehouse," and in a series of articles giving this system, which he published in Gleanings in Bee Culture in 1906 and 1907, he spoke of the value of large amounts of sealed *natural* stores, which are necessary for the bees to have during that period of the year when there is likely to be little or no honey coming in. He argued that the bees would have a comfortable feeling of wealth or "millions at our house." He likewise contended that if the bees were short of stores, or had only those stores that were in the brood-nest, they would curtail brood-rearing at a time when it was most important for the securing of a honey crop. But Mr. Doolittle did not at this time contemplate giving this large reserve of sealed honey in a hive-body or super to the bees the fall previous, but only in the spring.

Along in these early days, Doctor C. C. Miller, frequently mentioned in this work, used to save out in the fall a large number of combs of sealed honey. These he gave to his bees from time to time in the spring as needed. He was a firm believer in natural stores instead of syrup.

A. I. Root, the first author of this work, as will be seen in the original editions, strongly advised against extracting too close and then feeding sugar syrup to replace the honey taken out. He argued that it was poor economy even though the sugar syrup was cheaper than honey. He contended further that it was not as good for the bees; but none of these old pioneers ever thought of giving a whole super of *natural stores in the fall.*

As has been explained in the Preface, the author early began to exploit the advantages of breeding in two stories instead of the usual one story. (See Gleanings in Bee Culture for 1894 to 1901.) Geo. S. Demuth, for thirteen years editor of Gleanings, was one of the first to adopt this principle of a two-story ten-frame Langstroth brood nest and continued to advocate it after he took over the editorial management of Gleanings. It was but natural that he should go one step farther and make one of those upper stories a food-chamber.

The two ideas of breeding in two stories and the development of the food-chamber have revolutionized beekeeping in the United States. Mr. Demuth as early as 1911 advocated putting this super of good honey on a colony early in the fall. The bees gradually eat out the stores, forming a winter nest between the upper and the lower stories, and, in the language of Doolittle, they have "millions at our house." With this large reserve of natural stores, it was unnecessary to feed in the fall, unnecessary to feed in the following spring. There would be stores enough (from fifty to sixty pounds) to carry the bees over until the next honey harvest. While the bees might not use all the stores, they had "millions at their house," with the result that brood-rearing, providing there was a good queen, went on at full pace from the early part of the spring clear up to the beginning of the harvest. See his series of articles on long-range beekeeping and the food-chamber in Gleanings in Bee Culture for 1919 and 1920.

Mr. Demuth was forced to adopt the food-chamber idea as he had accepted a position in 1911 under Doctor E. F. Phillips in the Bureau of Entomology, a position that required him to be absent from his bees eleven months in the year. Mr. Demuth continued this way for nine years, while he was in the service of the government, and during this period he often made as much or more money with his bees in one month than he made in the service of Uncle Sam for eleven months.

In 1920 Mr. Demuth accepted a position as editor-in-chief of Gleanings in Bee Culture. His bees, up until the time of his death, were operated on the food-chamber plan, and all the attention they received was during a period of about a month scattered over at different intervals through the season, at the close of which the crop was taken off the hives and the food-chambers put back on. In October the bees were packed for winter, after which they received no attention until the next harvest period came on.

Mr. Demuth was very modest about his claims concerning the food-chamber, which he at first called the "automatic feeder," when out on lecture trips for Uncle Sam from 1912 to 1919. He said that there were others who were working

on the same idea, notably Morley Pettit and E. D. Townsend. Whether these two got the idea from Mr. Demuth is not clear, but at all events we find both Townsend and Pettit advocating the food-chamber in 1921. Mr. L. S. Griggs, of Flint, Michigan, is another one who has been using the food-chamber idea most successfully.

M. H. Mendleson, of California, one of the most extensive beekeepers of his state, and one well informed on California beekeeping, heard Mr. Demuth on his tour of the state in 1919 urge the adoption of the food-chamber as the panacea for California beekeeping. Mr. Mendleson said that he had always noticed that the colonies in two stories, the upper one filled with honey, were always the ones to furnish a crop of honey if there was one to be had. This was particularly true in the orange-grove regions where the honey flow is early.

All of these people have adopted the food-chamber primarily to cut down labor and cost of sugar. As the bees consume the stores in the second story, it automatically provides room for the expansion of the colony at that time of the year when the queen should have unlimited egg-laying room.

Perhaps the only reason why all the beekeepers in the country have not adopted it is because it seems pretty difficult for them to lay aside a super of the best honey, knowing that that honey will sell readily and bring all the way from six to twenty cents a pound, the latter figure if the honey is sold at retail. The prospect of immediate cash seems to be too alluring for many beekeepers, with the result that they are compelled to feed sugar syrup at an enormous cost, as has already been pointed out. They do not appreciate the fact that a food-chamber of good honey put on the hive in the fall is about the best investment that they can make. It is cheaper in the end than sugar syrup and besides honey is nature's food.

FOOD VALUE OF HONEY.—See Honey, Food Value of.

FOULBROOD.—Under this head will be discussed the various diseases that attack the brood of bees. Some of them give off an offensive odor, hence the name, and two of them at least are worldwide in their occurrence. First, and admittedly the most destructive and virulent, is American foulbrood, caused by the spore-forming bacterium, *Bacillus larvae*, because honeybee larvae is its only host; second and very much less destructive and more easily cured is European foulbrood caused by *Bacillus alvei.** The former was called in Europe virulent and the latter the mild form of foulbrood. The cause of American foulbrood was discovered and isolated by White, an American. The cause of European foulbrood was discovered by Cheyne & Cheshire of Europe and hence the geographic distinction. There has recently been discovered by Burnside and Foster in Florida and adjoining states a new brood disease that has some of the characteristics of both American and European foulbrood and which they have called para foulbrood, caused by *Bacillus para alvei.* There is still another form so mild that it seldom gains any headway and hence little attention is paid to it. It goes under the name of sacbrood, so named from its resemblance to a sac at a certain stage of development.

American Foulbrood, the Most Common

American foulbrood, sometimes called "ropy" foulbrood, because the dead matter assumes a gluey, sticky tenacious character, was well known in Europe, and has been referred to by Dzierzon and other writers. But Moses Quinby of St. Johnsville, N. Y., was the first one to recognize it in the United States and prescribe for its cure. The Quinby cure is the basis of one of the modes of treatment known as the shaking plan.

As a general rule, the beekeeper will not discover it in its incipient stages. He is not expecting it, and, if it comes, does not see it. His first intimation of its presence will be occasional cells of sealed brood showing sunken, greasy cappings and cells with irregular perforations. American foulbrood is confined mainly to brood that has died after the cells have been sealed; but from a very few to 75 per cent of unsealed cells may show dead brood and the dead in both sealed and unsealed will vary in color from a yellowish brown to a dark brown, and finally to a brownish black. The larvae that has just died holds its shape and lies lengthwise. As the decay advances it begins to shrink, and the dead matter becomes so rotten and putrid that the skin decays and the whole mass flattens down on the under side of the cell. It is then very

*See top of page 318, left hand column.

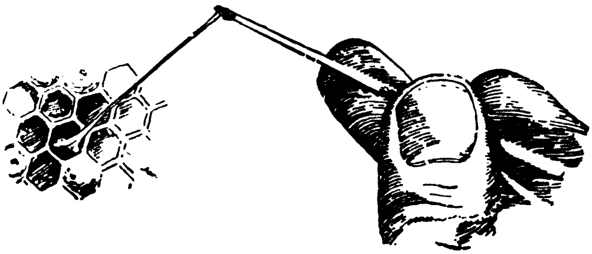
ropy, sticky, and tenacious. As this dries down it forms a hard scale that sticks tightly to the cell wall. These scales are not readily seen by looking straight into the cells; but if the top of the comb is tilted toward the observer and held so the light will shine into the cells, the scales can be seen on the lower cell wall. In American foulbrood the scales lie in uniform position (See Fig. 1 page 307, from Bulletin 1713), while in the European type their position is somewhat irregular, or in coils in the bottom of the cells. (See Fig. 3, page 313.) The scale of European foulbrood does not adhere so tightly and may be removed. The worst specimens of American foulbrood are usually found in the cells that have been sealed, although the melted broken-down form of larvae will be found in some unsealed cells.

The initial stages of American foulbrood are usually confined to the sealed cells. After the disease has advanced so that 75 per cent of all the sealed brood in a comb is affected there will be found quite a sprinkling of stray cells of young larvae that have never been capped over that are dead. But usually the grub will be almost fully grown before it dies in the unsealed cell, tending to show that American foulbrood does not usually kill the larva until after it is sealed in the cell.

European foulbrood attacks the larva early in its coiled state in the bottom of the cells and, of course, in unsealed cells. The dead larva will have a light yellow color. It loses its well rounded opaque appearance and becomes slightly translucent so that the trachea may become prominent. (See Fig. 3B, page 313.) The American may be found at any time of the year when brood-rearing can take place; but the European usually shows up at its worst early in the season in weak colonies before the main honey flow.

One may find occasional dead larvae just before sealing that do not indicate disease of any sort. A few such scattered over the combs may be due to starvation — that is, improper feeding. This occurs occasionally when there is too much brood for the number of nurse bees in the hive. One will occasionally find dead brood, due to chilling or overheating. When the brood area expands too fast in the spring, an occasional cold night will cause the cluster to contract, leaving some of the brood uncovered. This chills and dies, and is carried out and deposited at the entrance. The larvae will be white or slightly grayish, but not brown or yellow as in either of the foulbroods. All such dead brood should be distinguished from brood affected with either European or American foulbrood. If, after a week or two, no more dead larvae appear, one may assume there is no disease.

On the other hand, if one finds larvae that are dead and an increasing number of them as the days go by, especially if they are brown or yellow, he may suspect trouble. If the dead larvae seem to melt down, lying on the lower side of the cell, and if, further, they turn yellow or brown, and take on a tenacious, gluey consistency, it is an indication of American foulbrood. If a common toothpick, thrust into the dead matter, and given a little twist, and drawn out, leaves a fine thread one or more inches long, it is an indication of American foulbrood. If nearly *all* the dead larvae, especially those in sealed cells, show this ropy or stringy appearance, the indication of American is very much stronger. In this connection it should be stated that European foulbrood in some stages will rope; but the thread is coarser, somewhat lumpy, and is more of a salve-like consistency. Only occasional cells will show a tendency to rope, and even then only after considerable



From Bulletin No. 1084, Bureau of Entomology.

Combs showing the irregular, mottled, scattered cells with the perforated and sunken cappings of American foulbrood.

poking. The *occasional* ropy cells prove nothing.

The roping test alone must not be considered as conclusive that the disease is American. If, after a few days, some of the dead matter dries down into a hard scale so that it can not be removed without destroying the cell to which it is attached, one may conclude that he has real American foulbrood. While the scale of European will dry down, it seldom or never adheres tightly to the cell wall.

Once more: If, on careful examination, one finds here and there a few dead pupae—that is, young bees almost fully developed—lying on their backs with their tongues projecting upward, sometimes full length and sometimes half way, he has another indication that he has the American before him. Sometimes these projecting tongues seem to be glued to the upper wall of the cell. (See Fig, 2, page 308.) Sometimes they project upward only half way; but wherever these projecting tongues are found it is a good indication of American foulbrood. However, these projecting tongues while never found in European foulbrood, are sometimes found in para foulbrood described further on.

The name "foulbrood" suggests a foul odor. In the case of American the smell is very much like that of a cabinetmaker's gluepot. With European there is a sour or yeasty smell in the first stages. In the later stages of European the odor is

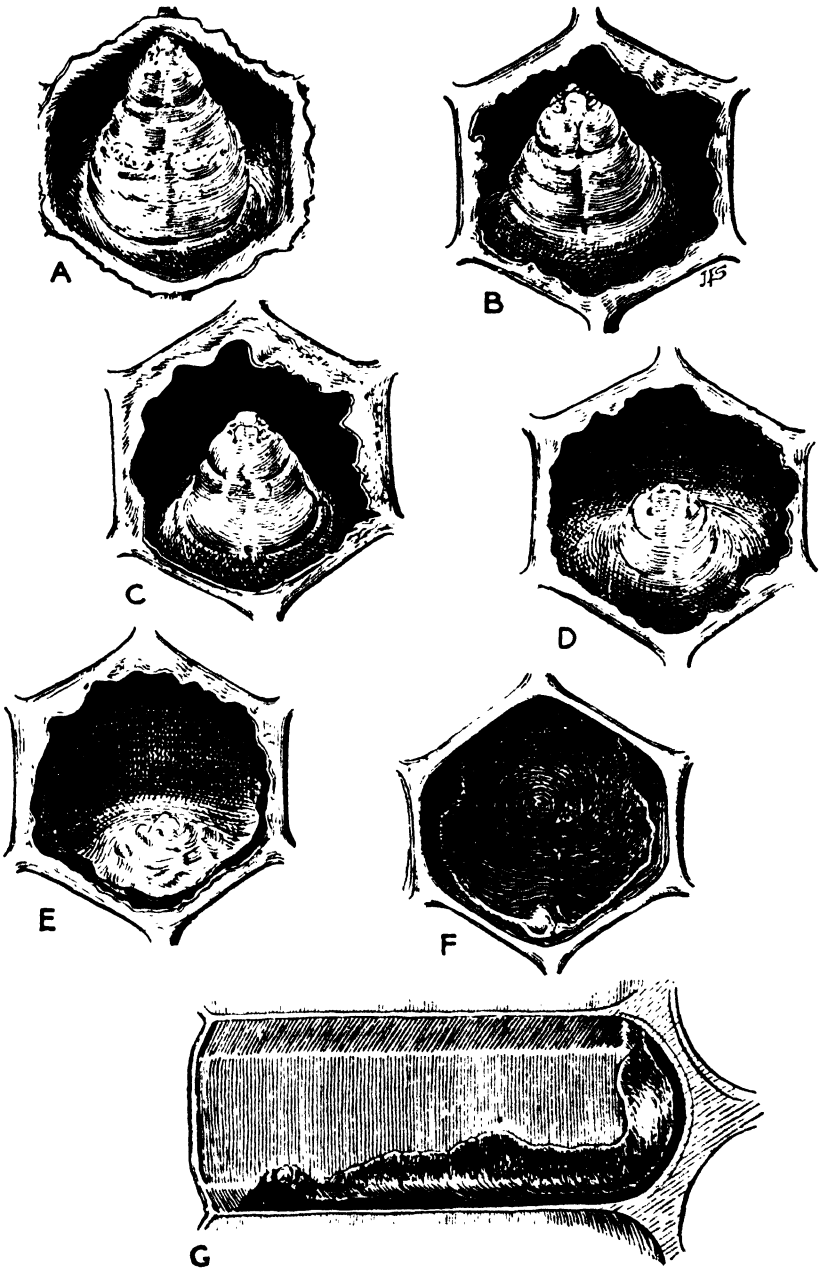


FIGURE 1.—Stages in the decomposition of larvae (prepupae) dead of American foulbrood: *A*, Healthy larva at the age when most of the brood dies of American foulbrood. *B, C, D, E*, Progressive stages in the decomposition of dead larvae. These stages can usually be detected only by removing the cappings. *F*, Scale of American foulbrood. Except in new combs the scale is difficult to see by looking straight into the cell. The comb should be held so that the line of sight falls on the long floor of the cells. This can be done by grasping the comb by the top bar and holding it 8 or 10 inches below the eyes and tipping the bottom bar slightly away from you. *G*, Longitudinal view of an American foulbrood scale.

—From Government Bulletin, Department of Agriculture, No. 1713.

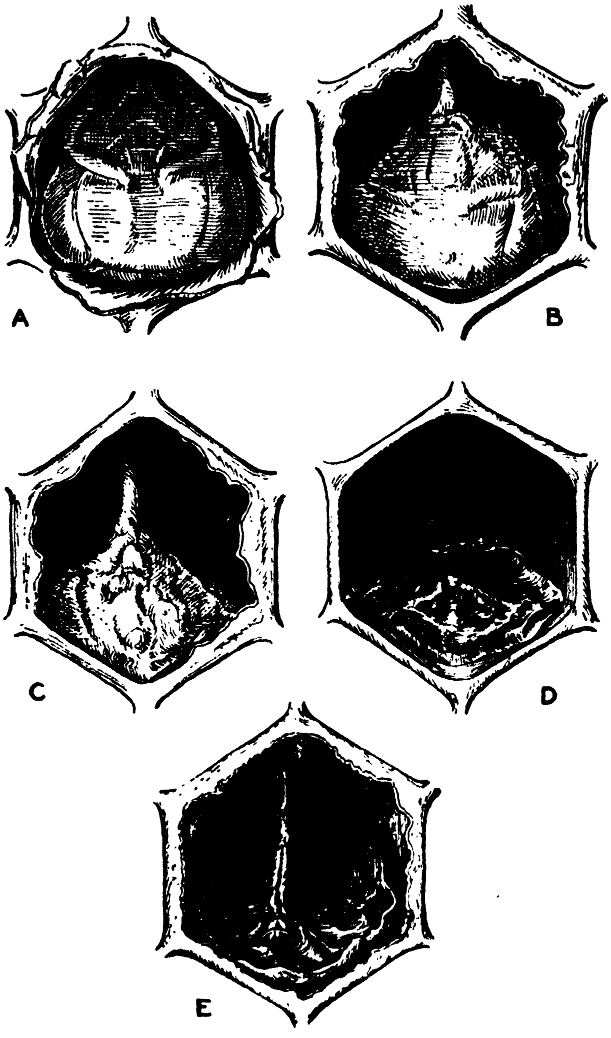


FIGURE 2.—Stages in the decomposition of pupae dead of American foulbrood: *A*, *B*, *C*, Heads of pupae showing progressive stages of melting down and decay. In *B* and *C* the tongues show prominently. *D*, Scale of American foulbrood formed from the drying down of a diseased pupa. *E*, Scale of American foulbrood formed from the drying down of a diseased pupa, with a vestige of the tongue adhering to the roof of the cell.

—From Government Bulletin, Department of Agriculture, No. 1713.

very bad, reminding one of dead fish or old carrion that has been allowed to stand for a considerable length of time. The odor of American foulbrood is not nauseating, but nevertheless it is quite characteristic. Neither is the odor of European foulbrood nauseating in its early stages. Sometimes it is very hard to detect any odor.

One who is expert can very often locate the disease by these odors; but it should be remembered that the odor alone is by no means conclusive; but in connection with the *other* symptoms it is very helpful in enabling one to decide what form of brood disease he has.

On one occasion the author located a colony having foul brood by an occasional suspicious odor he could catch at the entrance; but it was nearly a week after that when he found one cell containing dead matter. Apparently, the colony had nearly cured itself. But there still remained a characteristic odor which could

not be eliminated. Experience shows that a colony which seems to cure itself does not stay cured. It may be vigorous enough to keep the disease down to some extent; but an occasional cell will manifest itself for several years, and in the mean time be a constant source of infection to all the rest of the apiary. There might be some colonies that would not be able to resist, hence the danger.

The Odor of Dead Bees Like That of American Foulbrood

Sometimes one can detect a gluepot odor at the entrance of one of the hives. He may be alarmed and conclude that, because he has perceived the unmistakable smell, the disease is surely present in his apiary. This fear will be dissipated if he understands that the same foulbrood odor, or at least one very much like it, may have come from a lot of putrid dead bees after a severe winter. These dead bees may be found in the hive or at the entrance. Again, overheated brood or chilled brood, if neglected until it fairly rots, will give off a similar odor.

Pinhole Perforations

There is a kind of pinhole perforation that does not signify anything wrong—indeed, quite the contrary. As bees seal up their brood, there is a stage when there will be a small round hole in the center of the cap. Sometimes these holes are not closed up, and then there is what is called bareheaded brood. But the perforations are very different from the perforations in cells containing foulbrood, either American or European. The bad cells will have sunken cappings. The perforations are ragged, triangular, and the edges appear to be somewhat greasy, while in the perforations in bareheaded brood the cappings are slightly convex, and the hole is circular.

How American Foulbrood is Carried to Neighboring Hives

When a colony is badly infected the disease has progressed to such a stage that the probabilities are that other colonies in the same locality are infected, especially those having entrances pointing in the same direction or similarly located. At this point the beekeeper should be warned that colonies next to the one badly infected are very apt to show the disease. This is explained on the ground that young bees, and even the adult ones become more or less confused at their entrances, and so get into the wrong hive. As they do not ordinarily show any of the manifestations of robbers, they are admitted. If they carry honey from an infected colony, as many of them do, they will transmit the disease as soon as pap is made out of such honey and fed to young brood. That explains why there will be only a single cell or a group of cells, perhaps one square inch, that will have foulbrood, while all the rest of the brood in the hive is perfectly normal. If one can be sure that the comb containing the diseased cell or cells is the only one affected the removal of that comb might effect a permanent cure. But American foulbrood is so virulent that the procedure would be very dangerous and the author does not advise it.

Treatment and Cure of American Foulbrood

This disease is much more difficult to eradicate than any of the other brood diseases under this head. The reason for this is that *Bacillus larvae* the cause of American is a spore-forming bacteria and these spores may live in honey, in combs, and in hives for many years—just how long no one knows. It is known that they are exceedingly resistant to extremes of heat and cold and continued exposure to light. Even boiling water will not kill them, unless they are kept at that temperature for 20 minutes.

The Shaking Treatment in This Country and in Europe

For many years shaking bees on comb foundation in clean hives and then burning the infected combs and frames was considered orthodox and reliable for American foulbrood, and it is yet under some conditions in the hands of an expert. To avoid reinfection the work of shaking or brushing the bees off the diseased combs should be performed at or toward night. The bees should fall on a newspaper spread out in front of the clean hive to receive the bees. The purpose of the newspaper is to catch any drip of honey from the infected combs and to provide an easy runway for the bees back into the new hive.

After all the combs are shaken or brushed clean onto the paper they are immediately burned in a pit previously dug in the ground at least 18 inches deep. Before throwing the combs in the pit there should be a hot roaring fire of wood so that the combs, frames and the brood

shall be reduced to ashes. After all infected material, including the newspaper, is burned, the loose dirt is thrown back into the hole. Any honey or wax or frame left not completely consumed, if not buried, might scatter infection right and left the next day by robber bees. The hands are washed in soap and water.

Experience shows that the wooden frames and the wax should be burned. Any attempt to save either involves a great risk in planting American foulbrood back into the yard.

The old hive that contained the diseased colony is scorched out on the inside with a painter's blowtorch or scraped and thoroughly washed out with hot lye water. This treatment saves the bees and the hives if in good condition.

There are some who cut out the combs, melt them and save the wax. But the wax saved could not be over four ounces or a quarter of a pound per frame, or 2½ pounds per brood chamber. Experience shows that the amount of wax saved and the cost of a wax press barely pays for the labor, to say nothing of the great risk of reinfection.

Sterilizing the Combs in a Disinfecting Solution Not a Success

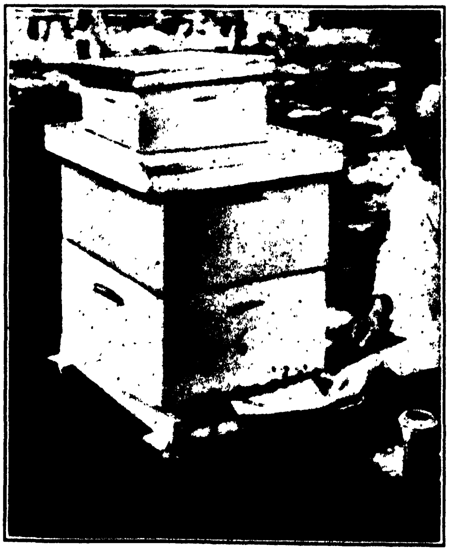
A few years ago some success was apparently achieved in soaking the infected combs for 48 hours in a solution of one part formalin and four parts alcohol, or what was known as the Hutzelman solution. Later on it was shown that water could be substituted for alcohol and at very much less expense. (See Bulletin No. 284, Department of Agriculture, Washington, D. C.) Both the water and alcohol solutions seemed for the time being to afford hope that the combs could be saved and used over again; but as time went on, recurrences of disease in the combs so treated was continually cropping out, so much so that the bee inspectors of the country as well as beekeepers themselves gave up sterilization by this means as ineffective and dangerous. Likewise sterilization through the agency of gases was even less effective if anything than the solutions. While the spores of American foulbrood can be destroyed by solutions or gases none of them will kill them in honey without destroying the combs or making the honey unfit for use, but the solutions are good for treating extracting combs of doubtful history.

The Shaking Treatment for American Foulbrood Found Wanting

It is becoming more and more apparent as the years go by that the shaking treatment as ordinarily applied has not been satisfactory; that in some and in most cases where treatment has been left to the beekeeper himself foulbrood has actually been spread rather than controlled. Inspectors have been saying for several years back that where the burning plan was adopted the disease was being wiped out, and that where the shaking process was used, the disease was increasing.

The Only Safe and Sane Plan

Bee inspectors everywhere are now advocating applying treatment immediately after discovering the disease. In other words, the inspector, before he leaves the premises, burns up bees, combs, frames, any and all infected material, including honey and brood. This burning usually takes place at night in a pit 18 inches to



Method of killing the bees with calcium cyanide before burning. A tablespoonful of calcium cyanide is placed on a sheet of paper, when the whole is shoved into the entrance as above shown. The bees will be quickly killed, after which the infected mterial is burned and the hives if good are sterilized.
—From Bulletin No. 1713.

two feet deep, large enough so that all the ashes can be later covered by fresh dirt. In other cases, the inspector has been burning bees and diseased combs in a pit and burying the ashes, but has per-

mitted the owner to retain the hives after they had been suitably sterilized, either by scorching out the inside with a blowtorch or by scraping the insides of all the hive parts, covers, insides of the hives, bottoms and tops, and then washing with a solution of lye or soap. Where either complete or partial burning has been used, as just explained, and applied on the very day of the discovery of American foulbrood by the inspector, the disease has been cleaned up. The inspectors are almost unanimous on this point, and they are now urging the bee journals and textbooks to get into line. They complain that they are handicapped because the beekeepers object saying the bee journals do not advocate burning.

In Farmers' Bulletin No. 1713 of the United States Department of Agriculture, page 9, the burning treatment is advocated as "the safest and in the end, the most economical means of stamping out American foulbrood." It adds, "Diseased colonies should be burned as soon as possible after the infection is discovered. Before this is done, however, the bees must be killed," by the use of calcium cyanide or by the use of carbon bisulphide.

Perhaps the bees could be saved by the shaking plan, but experience seems to show that the nurse bees coming back into an empty hive are liable to scatter all over the neighborhood and thus spread the disease. It is here particularly that the shaking treatment fell down.

The government bulletin goes on to say further, that the hives, covers and bottoms can be saved if thoroughly disinfected by the use of fire or by scraping and scrubbing with soap and water, or lye water.

In view of all the evidence presented, and especially since James I. Hambleton, head of the Bee Culture Laboratory, advocates in this bulletin the burning treatment, the author feels that he should get into line, and advocate the method that is sanctioned by the Government and is being used now by practically 98 per cent of all the state bee inspectors.

What to Do Where There is Forty or Fifty per Cent Infection

It may be urged that the burning treatment would be pretty hard on the beekeeper who suddenly found forty or fifty per cent infection in a yard of 100 colonies. Most of the state laws allow the bee inspector to use his own judgment in such cases. He might and probably would allow the owner to save his bees and hives but require him to burn all diseased combs in a pit as before described. There would be danger of recurrence in the other colonies in the same yard if not in the hives treated. The inspector doubtless would require that the work should be done immediately and in his presence, or that of a deputy, and in addition place the yard under quarantine until the entire yard was proven to be clean.

In the first place, it is a poor beekeeper who would allow forty or fifty per cent of infection to get into his bees. He should not blame the inspector if he burned up the complete outfit. His neighbors might demand it of the inspector and even then, the yard might have to be held under quarantine to see if there were any more infected colonies. With so large a percentage of disease, the other colonies not showing it for the time being, might develop it later and hence the need of a quarantine.

It should be explained that where the state or state inspector has adopted the policy of complete burning except the hives that the percentage of infection would rarely go above one or two per cent. Such has been the case in Florida, where it has for many years been the policy of burning immediately after the disease is discovered.

As nearly all the other states have since adopted the Florida policy of burning, it is believed that they will soon be as clean of bee disease as Florida.

The fact seems to stand out that the shaking treatment has not reduced American foulbrood in states where it has been the policy. In the hands of the average beekeeper, who does not understand how American foulbrood can come back through failure to follow directions, the disease has usually been spread.

The author has followed in this discussion of American foulbrood the advice given by Jas. I. Hambleton, head of the Bee Culture Laboratory, in his bulletin No. 1713, issued by the Department of Agriculture, Washington, D. C. The reader would do well to send for a copy. The plates here reproduced are copied from the bulletin above named.

European Foulbrood

Fortunately this disease does not offer the difficulties encountered in American foulbrood. Its treatment is simple and not

expensive. As it may easily be mistaken for the more virulent form of foulbrood, it is important to make a careful differentiation between the two diseases. It is unnecessary to burn the colonies, much less the combs, in the European type of disease. To apply the shaking treatment as described for American only makes the matter worse. As in the case of American so the author advises in suspected European—sending a sample to the Bee Culture Laboratory, Department of Agriculture, Washington, D. C. As it takes time to do this, and get back a report, from what follows, the reader may be able to determine whether he has the virulent or mild form of the disease and apply treatment accordingly. It is hoped that the following if carefully read may enable one to decide immediately which disease he has.

European Foulbrood Differentiated

As has been already explained, this disease as well as para foulbrood, has some symptoms that are similar to those of American foulbrood; but it has other symptoms that are quite different. In general appearance, especially in its advanced stages, a comb having the disease will look somewhat like one containing American foulbrood; but a more careful examination will show a decided difference.

1. Larvae affected with European foulbrood in its first stages are not usually ropy, but when they do rope the thread is coarser and does not string out as far. American will often rope from one to three inches in a fine thread near the end. The dead matter of European has more of a jellylike consistency; and, if it clings to a toothpick, the roping is coarse, lumpy, and salvelike, and will not extend more than an inch or two at the most and then break like a rotten rubber band.

2. European in its first stages comes on mainly in the early part of the season, and it is confined largely to the unsealed brood. The young dead or dying larva will be found coiled up in the bottom of the cell. (See Fig. 3, A, B, and C.) They first turn gray, then light yellow. Sometimes a yellow spot shows in the center of the grub before it turns yellow all over. It does not finally assume a shapeless melted-down mass as is found in the American disease. The dead larvae will often be twisted slightly. (See Fig. 3, D and E.) It retains its shape otherwise without a break in the skin, finally shriveling up into a dry scale which the bees easily remove. The dried scales of American foulbrood, on the contrary, stick to the side of the cell like so much glue; and it is very easy to detect combs previously affected with this disease, although it may be a year or so afterward, because the lower sides of the cells look as though they had been daubed over with some sort of dark-brown gluey substance with a remnant of larval skin.

3. The ordinary gluepot or foulbrood odor is almost entirely lacking in combs affected with European foulbrood. There is, in place of it, a sour, yeasty, or rotten-egg smell that is not as easily recognized as the odor of the other brood diseases. In the later stages it takes on a spoiled-meat or carrion odor with a suggestion of ammonia, in which stage the sour smell seems to be lost or obscured by the more pronounced odor of decay. The color of European foulbrood in its earlier stages is a yellow or gray or combination of these two colors. Later the yellow and gray change to quite a dark brown.

4. European like para foulbrood, seems to spread much more rapidly than American. If an apiary is affected at all, more colonies will be involved than in the American disease. Nurse bees seem to be the main source of infection in the European type. While honey may be a source, this is doubted.

5. Black and hybrid bees are much more subject to the ravages of European foulbrood. The same is probably true of para foulbrood. If the disease is not too far advanced and the colonies are strong, the mere introduction of a vigorous strain of young Italian queens may cure the whole apiary. There were some localities in New York and Virginia where Italian apiaries were surrounded by apiaries of black and hybrid bees; and yet the remarkable fact is that these Italian yards were almost entirely free from disease, while the yards of black or hybrid bees around them were affected with it.

6. There also seems to be a general agreement among authorities that weak colonies are the ones that are first attacked by European. It is important, where this disease gets into a yard, that all the weak colonies be doubled up; for it is only the strong and extra strong that are able to combat it, even when they

are given every assistance possible on the part of the owner.

7. It has been noticed that, as soon as a good honey flow is on, European foulbrood begins to disappear; and sometimes as soon as there is a dearth of honey it breaks out again, particularly when brood-rearing is well under way in the

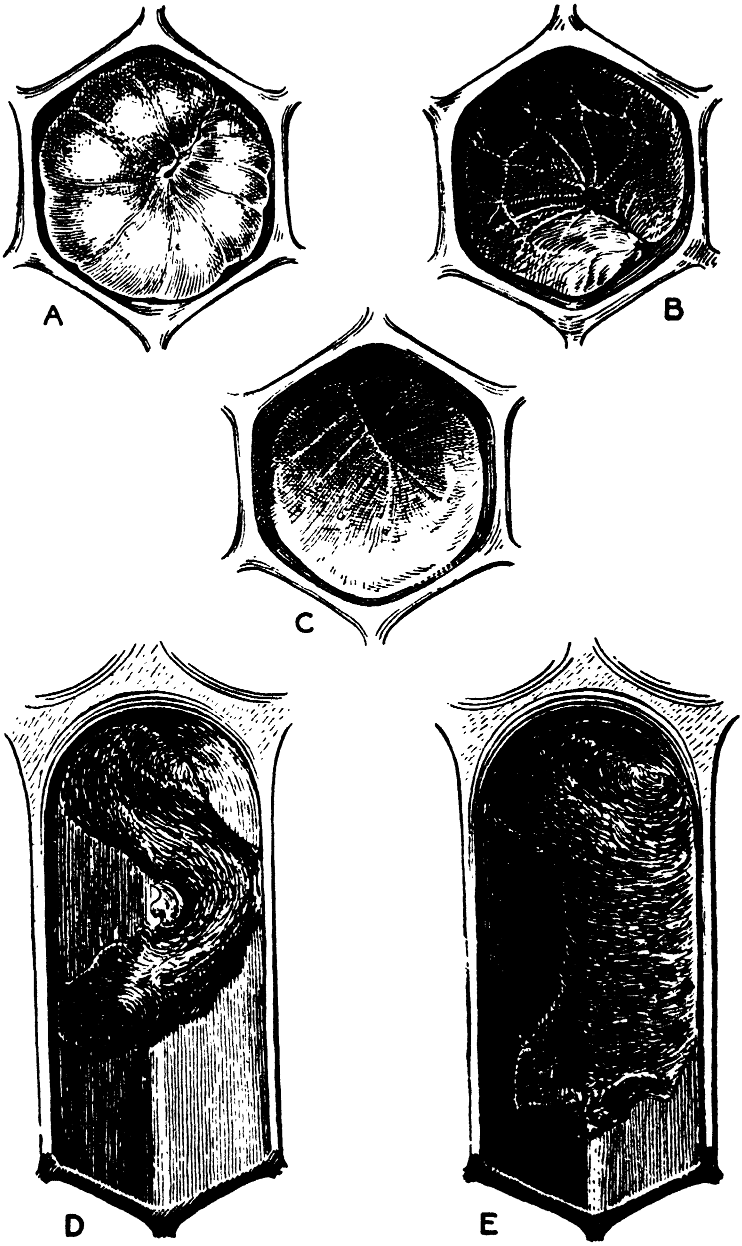


FIGURE 3.—Coiled and unsealed larvae sick or dead of European foulbrood: *A*, Healthy coiled larva at the earliest stage at which larvae die of European foulbrood; *B*, scale formed by a dried-down larva; *C*, one of several positions assumed by a sick larva prior to death; *D*, *E*, longitudinal views of scales formed from larvae that had assumed a nearly lengthwise position at the time of death, quite different from the scale shown in *B*.

—From Government Bulletin, Department of Agriculture, No. 1713.

spring, for that is the time of the year when it usually makes itself manifest.

8. In the case of American foulbrood it has been proven that combs or honey from a diseased brood nest are sources of infection. While the honey could be extracted out of the combs, it has been demonstrated that it is impossible for a colony of bees to remove the germs by any process, for the simple reason that the dead matter sticks like glue to the sides and bottoms of the cells. On the other

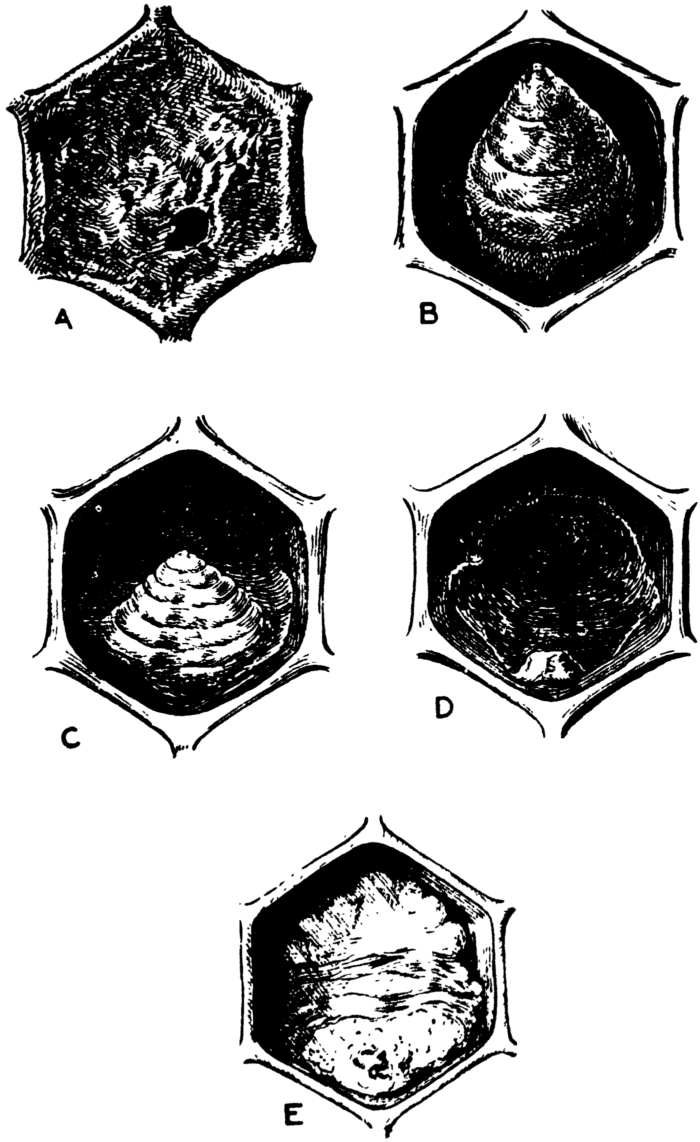


FIGURE 4.—Larvae (prepupae) which may or may not be in sealed cells and which are lying lengthwise at the time of death from European foulbrood. Stages similar in appearance to those illustrated here are encountered in American foulbrood. *A*, Sunken and perforated capping of a cell containing a larva dead of European foulbrood; *B*, larva lying lengthwise in the cell and recently dead of European foulbrood; *C*, same as *B* except in a more advanced stage of decomposition; *D*, scale formed by dried-down larva dead of European foulbrood; *E*, the remains of a larva dead of European foulbrood, part of which has been removed by the bees.

—From Government Bulletin, Department of Agriculture, No. 1713.

hand, the combs of European foulbrood and para foulbrood, because the dried larvae do not stick, can be readily cleaned up by a vigorous colony of Italians and used over again. Before they have been cleaned up they may transmit the disease. Hybrids and blacks, for some reason, do not effect this clean-up; and hence it is necessary to Italianize.*

To recapitulate, combs of American foulbrood must be burned. Combs of European foulbrood need not be destroyed, and can be used again, when given the proper environment. In the last stages of European, where the combs are rotten, they should be burned.

9. American foulbrood seems to be no respector of strains or races. European foulbrood, in the first stages on the other hand, yields rapidly to a resistant strain of Italians without the destruction of combs. But not all Italians are equally resistant. Some strains, especially the yellow, inbred until their vitality has been weakened, are no better than the ordinary blacks and hybrids.

It seems to be apparent that bees which are good workers, and stand wintering well, are usually found to be very resistant to European foulbrood, although the rule does not universally hold true. When Italians, therefore, are spoken of as "resistant," it should be remembered that there are Italians and Italians—some better than others.

Treatment and Cure of European Foulbrood

Before proceeding to the actual cure of a colony after the disease has been contracted, it should be stated that good beekeeping, according to the government officials, makes it very difficult for European foulbrood to get a start. This is only another way of saying that prevention is better than cure. Good beekeeping means strong colonies of good bees. Not only that, but they should be strong in the spring. In order to have such colonies it means good wintering; and good wintering, in the northern states at least, implies an abundance of natural stores and protection. (See Food-chamber, Building Up Colonies, and Wintering.)

In the milder climates, to have strong colonies in the spring requires a larger amount of stores to the colony; because when the bees can fly two or three times a week, many old bees are lost in the fields, never returning. The others that do return with nectar and pollen start breeding, and this calls for a large reserve of stores—at least double the amount required in the colder states.

In the treatments now about to be given for the cure of European foulbrood, after it once finds lodgment, it will be noted that the fundamentals are strong colonies, dequeening to allow the bees to clean up the infected material, and requeening with a resistant strain. Before we proceed to the exact details of treatment, the history of how the best methods were discovered is important.

In 1899 and the early 1900's, when European foulbrood was known in New York as a foulbrood that was different from the old-fashioned kind, the shaking method was applied exclusively. It was soon discovered that the disease was continually coming back.

In 1904 E. W. Alexander, of Delanson, N. Y., reported to the author that one of his neighbors had blundered upon a cure which he thought was effective. At that time he was not prepared to state whether it would bring about a cure or not; but after he had experimented with it on some 500 colonies he gave out what has since been called the Alexander treatment, which is now the basis of all the modern methods of control for the European foulbrood. In brief the Alexander treatment is as follows:

Every diseased colony in the apiary not very strong is doubled up or united with other weak colonies until all are made strong. In some cases building up or strengthening of the weak can be effected by taking frames of emerging brood from the stronger and giving them to the weaker. The next procedure is to remove the queen from every infected colony, and in nine days destroy every

*I think the diseases will not be transmitted by a diseased larva even though still undried, if it is so far decayed that the nurse bees will not eat it. By the way, this theory, original with me, has never been advanced by any one else, and, as it has never been objected to by any one, it is safe to say that it is the best theory yet advanced to explain how the disease is conveyed, and at the same time to explain how and why the dequeening or caging cures. Here's the theory in brief: When a diseased larva dies, the nurses suck its juices, feed them to the young larvae, and thus the disease is transmitted; but after the diseased larvae become so far decayed as to be offensive, the nurses will no longer suck their juices, but leave them to become dried, or remove them without sucking them. So a break in brood-rearing that leaves no longer any eatable diseased larvae stops the continuance of the disease.—C. C. Miller.

mature queen-cell, or any virgin if emerged. In the meantime a quantity of cells are to be reared from the best Italian breeder in the yard. These cells, when ripe, are given to the colonies made queenless 20 days before. During this interim of queenlessness the bees clean out the combs, polish up the cells, and when the new queen starts laying, which will be on the 27th day, approximately, the new brood will be healthy from that time on. It is not necessary to remove any combs from the hives nor apply any kind of disinfection. The old queens that were removed in the first place are to be destroyed.

In a series of articles which Mr. Alexander wrote defending his treatment—for he encountered all sorts of opposition from those who failed—he laid strong emphasis on the importance of making all colonies extra strong, using a vigorous resistant strain of Italians and keeping the colony queenless for at least 20 days, at the end of which time a ripe queen-cell or a virgin just emerged was to be given.

S. D. House, of Camillus, N. Y., told the author that a vigorous strain of Italians would almost alone clean out European foulbrood after the colony had been queenless for a period. He showed colony after colony that had been rotten with the disease, and which at the time of our visit was entirely free of it. He stated that European foulbrood was rampant all around him in the black and hybrid colonies. In spite of the fact that it was within reach of his bees he had no fear of it. He wrote a series of articles for Gleanings in Bee Culture in 1911, and among them was one, on page 330, giving his method of treatment that is similar to Alexander's. This attracted considerable attention at the time. The editor of Gleanings was severely criticised by some of the state inspectors for giving publicity to such heresy; but old Father Time has demonstrated that Alexander and Mr. House were nearly right.

In later years European foulbrood broke out in the apiary of Dr. C. C. Miller of Marengo, Ill., an authority referred to many times in this work. The author advised him to follow the Alexander, or, better, the House modified treatment, which he did with marked success. By accident he discovered that it was not necessary to have the colonies queenless more than ten days; that a vigorous strain of bees would do a good clean-up job in the period named. After experimenting with the disease for two or three years he finally announced the following modified Alexander-House-Miller treatment, which is much the same as that used by S. D. House. Dr. Miller says:

> First, no matter whether the case be severe or mild, make the colony strong. In a severe case, kill the queen; and as soon as the colony recognizes its queenlessness, say within 24 hours, give a ripe queen-cell, or immediately at the time of killing the queen, give a virgin not more than a day old or a cell in a protector. That's all; the bees will do the rest. In a mild case make the colony strong, and cage the queen in a hive for a week or ten days—only that. But don't expect the disease to be at once and forever stamped out. Last year I had the disease in a mild form in about one colony in four; this year in about one in twenty.

It will be noticed that Dr. Miller, like Mr. Alexander, emphasized the importance of making all colonies strong in the treatment of either a severe case or a mild one. Later on, after considerable discussion, he added this:

> A correspondent asks, "What do you do to save the combs?" Nothing. Just use them the same as if there had been no disease. Vigorous bees with a vigorous queen will clean them out. The disease may break out again; but in the long run the loss will be less than if the combs were destroyed, and possibly the returns of the disease will be no more frequent than if all combs are destroyed. In my own apiary I think there were no more fresh outbreaks where the old combs were left than where the bees were thrown upon foundation.

A large number have followed Mr. House and Dr. Miller and have been very successful. This does not mean that every trace of the disease will be wiped out after treatment, but it does mean that it will be brought so nearly under control that a case only here and there will show up, and even then in a very mild form. Some queens of a resistant strain are not quite so resistant as others. In that case dequeening for ten days and requeening again will complete the cure.

It should be noted that the presence or absence of an early honey flow makes considerable difference in the response of this disease to treatment. Mr. House and Dr. Miller were able to reduce the period of queenlessness because their locations furnished an early honey flow from white clover, which, in itself, causes the bees to clean out the dead larvae more vigorously, while Alexander's experiments were conducted in the buckwheat region where the honey flow does not begin until August, but little if any honey being gathered from white clover in June. This longer period before the honey flow in the buckwheat region or in any region

where the honey flow comes late gives European foulbrood a better chance and increases the difficulties in treatment.

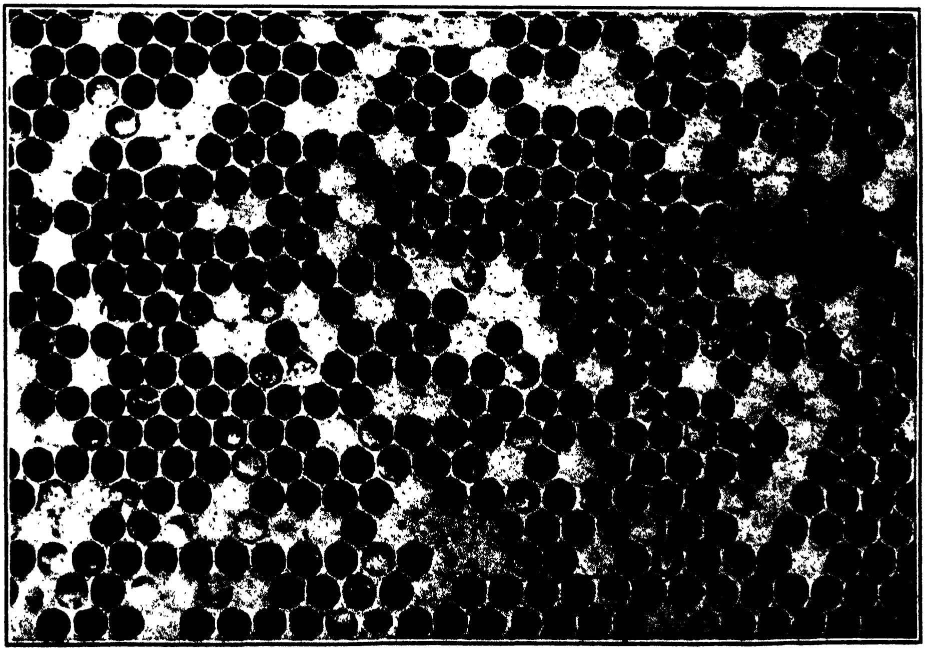
Para Foulbrood

Early in 1930 there was discovered in southern Georgia and northern Florida brood dead and dying that showed symptoms different than those of the known brood diseases. Samples of the dead brood examined by Dr. C. E. Burnside, Assistant Apiculturist and Bacteriologist in the Department of Agriculture, Washington, D. C., showed the presence of bacteria which differed from those encountered in American or European foulbrood. Some of the symptoms resembled those of American and others those of European. The larvae which died in the coiled stage, closely resembled those dead of European foulbrood, while the extended larvae and pupae had symptoms like those of American. Some of the brood remains were dark brown and showed ropiness like that in American foulbrood. It was observed that the bees easily removed the remains of the young larvae. The ropy remains were usually not removed until after they had dried down to scales which resembled scales of American foulbrood.

Laboratory Established to Study Disease

Early in March, 1932, in co-operation with the states of Florida and Georgia, the U. S. Department of Agriculture established a temporary laboratory at Thomasville, Ga., with Dr. C. E. Burnside in charge, with R. E. Foster, Florida bee inspector, assisting. The necessary bees, beekeeping equipment, and laboratory apparatus were furnished by the three co-operating agencies. In searching for infected colonies with which to conduct the experiments it was found that the disease had not yet appeared that spring in Georgia. Infected colonies were found in Suwannee County, Fla., where brood rearing had been in progress for a longer time. Later in the season this disease was found in Clinch and Echols Counties, Georgia, and Hamilton County, Florida. In June, the disease was identified in samples of brood sent to the Bee Culture Laboratory from Orangeburg County, South Carolina, and Wayne County, North Carolina. In November, 1930, it was reported from Pierce County, Georgia. A systematic survey to determine its range has not been made.

The names suggested by Dr. Burnside for this new brood disease and the bacterium found accompanying it are



An advanced case of para foulbrood.

para foulbrood and *Bacillus para-alvei*, respectively. These names have already been announced in Gleanings and other American bee journals. The name *para-alvei* was suggested for the organism because of its close resemblance to *Bacillus alvei*, the bacterium which is undoubtedly responsible for European foulbrood. Recent work by Lockhead* and unpublished work at the Bee Culture Laboratory have demonstrated that "*Bacillus pluton*" heretofore considered the primary cause of European foulbrood, is a stage in the life history of *Bacillus alvei*. The spore and rod stages of *Bacillus para-alvei* resemble stages of *Bacillus alvei*, but can readily be distinguished from them. There occurs also another form in this disease which resembles "*Bacillus pluton.*"

Appearance of Dead Larvae and Pupae

Italians, common blacks, Caucasians, and hybrid bees in the brood stage are susceptible to para foulbrood, although Italians and perhaps Caucasians appear to be less affected than common blacks and hybrids. Worker brood is affected to about the same degree as drone brood. Queen larvae are nearly always badly affected. Brood of any sex usually dies during the larval stage but occasionally worker brood was found dead in the pupal stage. At first the sick larvae appear perfectly normal but as the disease develops the larvae become restless and assume abnormal positions. (See cut.) Just before death the glistening pearly-white color characteristic of healthy larvae usually changes to a dull or grayish white. The remains of the youngest larvae are coiled on the bottom of the cells but most of the remains are irregularly or spirally twisted. A considerable number die in the late larval and early prepupal stages. Although relatively few pupae are killed, dead pupae are occasionally found which have already assumed considerable pupal color, and on rare occasions dried-down pupal remains are found with tongues protruding or adhering to the top of the cells. These pupal remains resemble closely those encountered in American foulbrood. Adult bees are not affected.

Some of the dead larva change color rapidly while others may retain a dull white or buff color for several days or even dry down to light-colored scales. Other larvae change from dull or grayish white to buff, light brown, reddish brown, or dark brown. As many as 20 per cent of the larvae die in sealed cells and practically all of these finally become dark colored. Tracheal markings are present in many of the larval remains.

Color changes are less noticeable in pupae than in larvae. At the time of death the larvae lose their plumpness or turgidity and become soft and flaccid. The skin remains tough for several days, enabling the larvae with some care to be removed entire. Recently-dead larvae are watery but soon become pasty. Some become ropy while others dry down to scales without showing this characteristic. Ropiness is occasionally present in larvae before the marked color change has taken place, but later these ropy remains assume the characteristic brown color. Practically all the remains in sealed cells become brown and ropy, while only part of those in open cells assume these characteristics. At times this ropy condition and the color closely resemble those encountered in American foulbrood, with the exception that the reddish tint is usually more pronounced in para foulbrood.

There is no characteristic odor in recently dead brood and most of the larvae in open cells reach the scale stage without developing an odor. Practically all the larvae which decay in sealed cells and some even in open cells develop an intense putrid odor. This odor resembles that of European foulbrood but in many cases is much more intense. The odor differences between the scales of European foulbrood and those of para foulbrood are not pronounced. However, in diagnosis in the apiary, the odor of para foulbrood is a valuable symptom.

Cappings over recently-dead brood appear normal, whereas those over brood remains more advanced in decay are frequently darkened, sunken and perforated. Cappings may or may not be perforated and occasionally, instead of uncapping the cells and removing the brood remains, the bees increase the thickness of the cappings. These thickened cappings are usually greatly sunken and some are sharply depressed in the center. Such cappings, which are dark and greasy in appearance, have frequently been observed late in the season after the colonies have apparently recovered. Sunken cappings have also been observed early in the spring be-

*1929. Lochhead, A. G. Studies on the etiology of European foulbrood of bees. Transactions Fourth International Congress of Entomology, Ithaca, 1928, p. [1005]-1009, illus.

fore the start of brood rearing. At first there is little noticeable change in the regularity of the brood, but in advanced cases the usual pepper-box appearance is present.

Erratic Spread in Colonies and Apiaries

In some cases the disease spreads rapidly within a colony. In others the progress of the disease is slow. The same is true in apiaries. Some apiaries may have only a few infected colonies, while in others every colony in the apiary will be diseased. Some colonies apparently clean out the brood as fast as it dies, while in others it is allowed to accumulate. The brood-remains in open cells are the first to be removed. The remains in sealed cells, being protected by the cappings, usually become ropy; consequently these are not removed until later. Dried scales do not adhere tightly to the cell walls; as a result the bees are able to remove them. No reason can be assigned at this time for the apparent differences in the degree of infection encountered in different colonies. It was readily noticed, however, in the course of the work that some colonies continued to harbor the disease without apparent serious damage, others were weakened to such an extent that no surplus was produced, while still others were killed outright.

The disease was readily transmitted in experiments conducted at the Thomasville laboratory, and observations made on infected colonies in Florida and Georgia indicate that para foulbrood is more infectious under proper conditions for transmission than American or European foulbrood. Robbing appears to be a prolific means of spreading infection and every precaution should be taken to prevent robbing in infected apiaries. Exchanging of brood, honey, or equipment in infected apiaries causes the spread of this disease and should be avoided. It is suspected that drifting is also a means of spreading this disease. This is indicated by the fact that the disease spreads soonest to colonies nearest to a badly infected one.

Owing to the number of points of similarity to European foulbrood, strong colonies of Italian bees and periods of queenlessness are being experimented with in the hope of finding a method of control. Furthermore, observations made in infected apiaries and results obtained thus far in experimental work on control seem to indicate that Italian bees and perhaps Caucasians are more resistant to para foulbrood than are common blacks and hybrids. Because of the seeming similarity between this disease and European foulbrood and the preliminary results obtained in these experiments, it is recommended as an emergency measure that owners of infected colonies practice the usual methods for the control of European foulbrood.

Summary

Para foulbrood, a new disease of the brood of bees, has been found in Florida, Georgia, South Carolina and North Carolina. The organism which is constantly present has been isolated and given the name *Bacillus para-alvei*, because of its similarity to *Bacillus alvei*. Some of the symptoms of this disease resemble those encountered in American foulbrood and others, those found in European foulbrood. Para foulbrood is extremely infectious, apparently being readily transmitted by robbing, by drifting, and by the exchange of brood or honey from infected colonies. Methods used in the control of European foulbrood are recommended for the time being for the control of para foulbrood.

As the symptoms of this new disease in so many respects resembles both those of European and American foulbrood, it is apparent that beekeepers as well as many of the inspectors will not be able to make the distinction between the diseases. The only safe way is to send a sample to the Bee Culture Laboratory, Department of Agriculture, Washington, D. C. This sample should be wrapped in oiled or paraffin paper and inclosed in a wooden box. It would be folly to burn up European foulbrood on the supposition it was American. It would be useless to shake in the case of European. It would, in fact, do more harm than good. Until we know more about para foulbrood it should be treated as for European foulbrood.

Heretofore it was always supposed that ropiness and the upwardly extending tongues were sure symptoms in American foulbrood. But the fact that they are also found in para foulbrood makes it all the more necessary to send samples to Washington, D. C.

As para foulbrood is found only in limited areas, it may be concluded that it is comparatively rare. The only two brood diseases that may trouble the beekeeper will be American and European foulbrood.

(The material for this description of

para foulbrood was taken almost word for word from Gleanings in Bee Culture, page 87, 1933.)

Sacbrood

For many years there has been recognized a form of dead brood under the name of pickled brood that is neither European, para, nor American foulbrood. It comes and goes at certain seasons, but is never as destructive as either one of these other diseases. Sometimes it has the appearance of foulbrood so far as color is concerned; but it is never ropy like the American type; and, while similar to the European, it seldom gains very much headway in a colony.

It is mildly infectious, and the infected larvae turn yellow and then brown. Sometimes the color is gray. The dead specimens may be in unsealed cells, but are generally in the sealed ones. The dead larvae, says Dr. White in Circular No. 169, Bureau of Entomology, are "almost always extended lengthwise in the cells, and lying with the dorsal side against the lower wall. . . . The form of the larvae dead of this disease changes much less than it does in foulbrood. The body wall is not easily broken, as a rule, and on this account often the entire larvae can be removed from the cell intact. . . . When removed they have the appearance of a small closed sac. This suggests the name of sacbrood."

Cause of Sacbrood

So far no microbe or fungus has been discovered as the cause of the disease. Whatever it is, it is so very small that it will pass through a Berkfield filter. Sick and dead larvae of sacbrood have been macerated and diluted with sterile water. The product was then passed through a Berkfield filter; but it was found that the filtrate would again give the disease to other colonies. It is evident that the disease is infectious. Dr. White concludes that "sacbrood is an infectious disease of the brood of bees caused by an infecting agent that is so small or of such a nature that it will pass through the pores of a Berkfield filter."

This leads us to the conclusion that the foulbrood inspectors of the country might be compelled to quaratine an apiary where sacbrood may be found; the Bureau does not think that this would be necessary. The disease in the past has not often been reported to have caused much damage.

Starved or Neglected Brood

There is another form of dead brood that very greatly resembles sacbrood; and that is, starved or neglected brood. Early in the spring, when natural pollen is scarce, and brood-rearing is well under way, some of the brood will die for the lack of the nitrogenous element of their food, obtained from pollen. It is starved, not from a lack of honey, but from a lack of proper bread-and-milk diet made up of pollen and honey. Considerable of this dead brood will be found in the early spring. The bees readily pick it out of the cells; and as soon as natural pollen comes in, the trouble will disappear.

Poisoned Brood

Sometimes brood takes on suspicious symptoms dying in early stages from poison present in nectar gathered from fruit blossoms sprayed when in full bloom. (See Fruit Blossoms.) At other times the brood is poisoned from nectar or pollen from undetermined sources. (See Gleanings in Bee Culture, page 470, for 1933.) Again brood as well as bees may die from the effects of the gases coming from great smelters in the vicinity.

In the case of the two last named, the obvious remedy is to remove the bees from the affected territory. In the case of spraying or dusting with arsenates or other poisons at the wrong time, the remedy is to show the orchardist that no possible good comes from such practice; that all experiment stations have advised against dusting or spraying when trees are in bloom. (See Fruit Blossoms.)

Dead Brood from Drone-laying Queens or Laying Workers

Under Brood, reference is made to the fact that drone brood or laying-worker brood will often be found dead, and a stinking mass. The cells will be perforated, and the odor will be very much like that from American foulbrood in an advanced stage. The fact that it does not rope rather suggests to the inexperienced that it may be European foulbrood; and many times A B C scholars write us, describing this trouble, and asking whether it is foulbrood.

The remedy is, of course, to remove the drone-laying queen or break up the laying-worker colony.

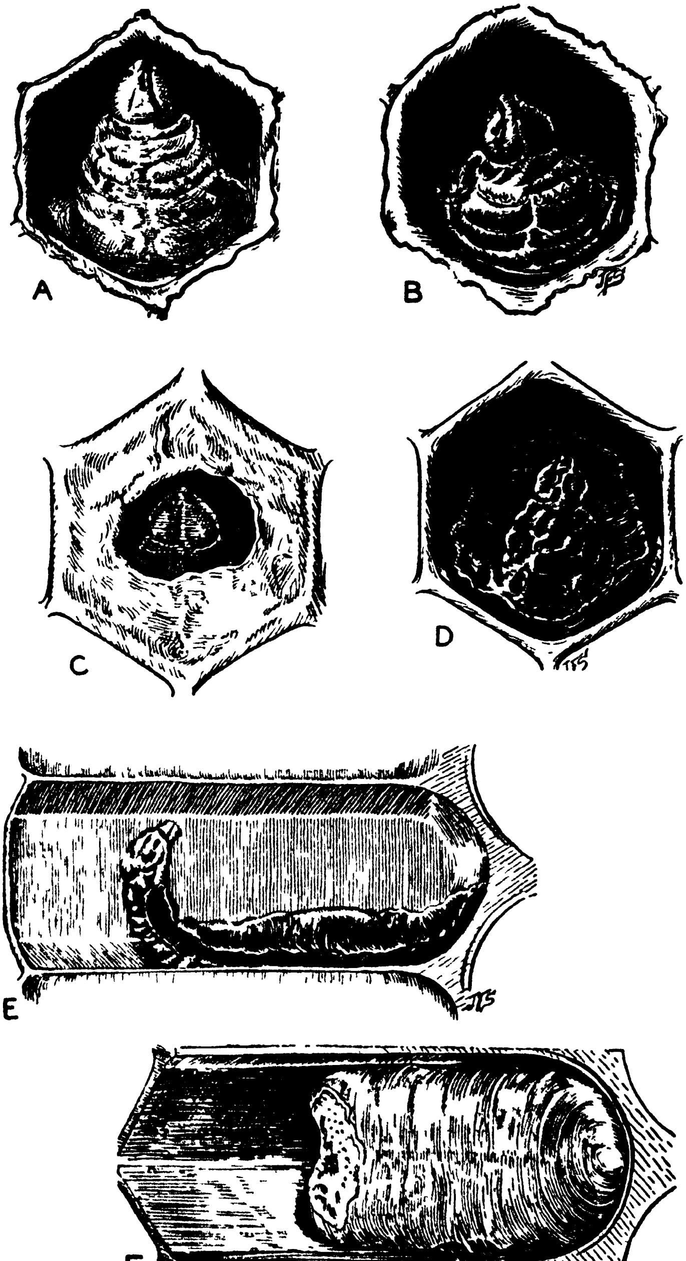


FIGURE 5.—Appearance of larvae (prepupae) dead of sacbrood: *A*, *B*, Stages in the course of the disease; *C*, the erect head end of a dead larva showing through an opening that the bees have made in the capping; *D*, *E*, two views showing the scale of sacbrood; *F*, the head portion of this larva has been gnawed away by the bees. Note how the head remains erect in all stages.

—From Government Bulletin, Department of Agriculture No 1713

FOUNDATION. — See Comb Foundation.

FRAMES.—These make up a very important part of the inside furniture of the hive. As the name implies, they are made of four strips of wood, fastened at the corners to hold the combs. They may be square or rectangular, and in the modern form are movable and separable and so designed that they may be held in a vertical position in the hive alone or in groups without special fastenings. While some frames stand on a bottom support, the great majority are suspended on projections at each upper corner. Frames make possible modern manipulation by which every comb can be inspected, removed, transposed—in fact, the whole inside of the hive can be determined. The straw skep and the box hive of olden days had no frames, nor does the same hive in use today in parts of Europe and southeastern United States. (See Box Hives.)

As shown under Hives, Evolution of, there were many crude ways of making combs movable—some better than others. Perhaps the crudest of all was to cut them out and put them back again. Later on, combs were built from single bars. This necessitated cutting the combs from the sides and bottom of the hive to effect a removal. To these bars were later attached other bars, making up a complete frame. But such frames were almost immovable. While they could be taken out of the hive it required a great amount of patience and time, to say nothing about bee-killing.

It remained for the Rev. L. L. Langstroth, of this country, then a Presbyterian minister, to discover a principle that would make every comb or frame removable. To construct a frame that will inclose a comb required no great act of invention; but to make a frame so it could be readily removed from its fellows, without mashing or irritating bees, required the work of a genius, and that genius was Langstroth.

Under the head of A B C of Beekeeping, Hives, Evolution of, and Bee-space it is explained that he discovered the principle of a bee-space — a space that bees respect, and never fill with comb or bee glue. Taking advantage of this principle, Langstroth saw that, in order to make his frame movable, he must provide a bee-escape all around. The next problem that he met was how to support and hold each frame so that there would be not only a bee-space all around between it and the top, bottom, and end of the hive, but also a bee-space between each and all of the frames. It is just as important to have every frame separable from its neighbor as separable from the hive. This he accomplished very nicely by making the top-bar of his frame long enough to have a projection at each end. These projections as a means of support were made to rest in rabbets in the upper edge of the ends of the hive. (See Hives and A B C of Beekeeping.) Langstroth, therefore, went ahead of his predecessors in two important points—in providing a bee-space and in giving a means of support so that the frames would not be glued fast to each other nor to the hive. His predecessors, as will be noted by a perusal of Hives, Evolution of, made their frames close-fitting, like drawers in a bureau, and each frame came in contact with its neighbor. (See the Huber hive under Hives, Evolution of.) These early devices, perhaps, would have been all right had it not been for three things—the ever present bee-glue sticking everything fast with which it came in contact, the crushing of the bees whenever parts of the frames came together, and the shrinking and swelling of the parts, making the frame anything but movable. A few crushed bees, many of them squealing with pain, will infuriate a whole colony; and it is no wonder that our forefathers resorted to the use of brimstone and refused to accept the so-called movable frames that were invented before Langstroth's. The so-called movable combs of Dzierzon made it necessary to cut every comb loose. This process necessarily caused a great deal of dripping honey. During a dearth of nectar this would cause robbing. (See Robbing.) When Langstroth, by his great invention of a really movable frame, demonstrated that he could make every comb movable—that he could take the hive all apart without killing a bee and without receiving a sting—he revolutionized for all time the methods for handling bees. While bees always will sting, and do sting, yet it is now possible, under favorable conditions and with proper use of smoke, to open and examine a Langstroth hive without receiving a sting. (See Manipulation of Colonies; also see Stings.)

The various crude attempts to make combs movable are set forth under the head of Hives, Evolution of. The methods of adjusting modern Langstroth frames in modern Langstroth hives are described under Hives and A B C of Beekeeping.

Langstroth desired to bring out a frame that would be really movable, and in doing so he went to the limit. His frames had no point of contact with each other. They were simply hung or suspended in the hive-rabbet. They often hung out of true, and worse still, were often badly spaced; but, in spite of all this, many beekeepers prefer the principle today. Most beekeepers consider it an advantage to have projections on the end-bars at the top, such projections being a half bee-space beyond the comb. These self-spacers will always hang true and the proper distance apart. (See Spacing Frames.) The advantages of these self-spacing frames are shown in the article on Frames, Self-spacing.

Size and Shape of Frames

There has been endless discussion as to the best size of frames. Some prefer one that is square—approximately a foot wide and a foot deep. Others consider 12 inches too great a depth, and prefer to have the extra comb area extend laterally. A great majority of modern beekeepers prefer today a frame longer than deep, such as we find in the Langstroth dimensions. As the dimensions of the frame determine the size and shape of the hive itself, a further consideration of the subject will be found under Hives.

Thick-top Frames

In the early 90's the thick-top frame was introduced to the public; but some years prior to that time J. B. Hall, then of Woodstock, Ontario, Can., had been using frames with top-bars 1 inch wide by $\frac{7}{8}$ inch thick. Soon after he began using them he discovered that the tops of these frames were free from burr-combs. Likewise there were no brace-combs between the frames. He made his top-bars thick, he said, not because of the burr or brace comb nuisance, but because he desired to prevent their sagging. It was not long after that Dr. C. C. Miller called the attention of the beekeeping world to Hall's discovery, and in a very few years the thick-top frame came to be almost universal. After the top-bars were made stronger and heavier, the end-bars as well as the bottom-bars were made thicker and wider. The natural result of all this was a stronger and more serviceable frame.

Before proceeding further, precisely what is meant by burr-combs and brace-combs should be explained. The former refer to those pieces of comb that were built in the olden days lengthwise and crosswise of the top-bars between the hive and the super or between the two sets of frames when the queen occupies both stories. Brace-combs refer to the strips of comb built between the top-bars. Burr-combs were much more troublesome. While the thickness and width of the top-bar are both important in the elimination of these troublesome combs, the width has more to do with their eradication than the thickness. A top-bar $1\frac{1}{8}$" wide by $\frac{3}{8}$" thick, provided the top-bar does not sag, will almost eliminate burr-combs, but not quite. If the top-bar sags, as will happen in the case of any top-bar less than $\frac{3}{8}$ thick, and as long as the Langstroth, it increases the bee-space to a point where bees will build burr-combs. To prevent sagging, the top-bar should not be less than $\frac{1}{2}$ inch. As the $\frac{7}{8}$ or, more exactly $\frac{13}{16}$, top-bar can be made just as cheaply, it has been thought to be more practicable to use the combination of a thick and wide top-bar $1\frac{1}{16}$" wide by $\frac{13}{16}$" thick.

In this connection it should be stated that the thin top-bar will not eliminate brace-combs; but one $\frac{13}{16}$" thick will do so better than any other size or form of top-bar.

Before the advent of thick and wide bars it was necessary to use a broad-bladed putty knife, or a common hoe or trowel to scrape the burr-combs from the frames every year, and sometimes two or three times a year. During the height of a honey flow, whenever a super or upper story was removed it was necessary to break these attachments between the upper and lower stories—not an easy job, by the way. Each time there would be a lot of bleeding or dripping honey all over the bees, combs, and clothing, to say nothing of stings and of the hands being smeared with honey. Practically all modern bee-hive factories are now furnishing their trade thick and wide top-bar frames almost exclusively.

After the thick top-bar was introduced it was impracticable to use vertical wiring that had been used with the old $\frac{7}{8}$ by $\frac{3}{8}$ thin top-bars. Horizontal wiring

was then introduced. (See Comb Foundation, subhead Wiring Frames.) At the time thick top-bars were introduced, in the early 90's, comb honey was produced much more generally than within the last few years. It was a great advantage to get away from the burr and brace combs so troublesome between the brood-nest proper and the super containing sections. It is not at all strange that the beekeeper, when he bought new equipment, would purchase that which would relieve him from this nuisance. In later years the tendency of the beekeeping world has been toward the production of extracted honey. This was particularly accentuated during the period of the World War, 1914-1918.

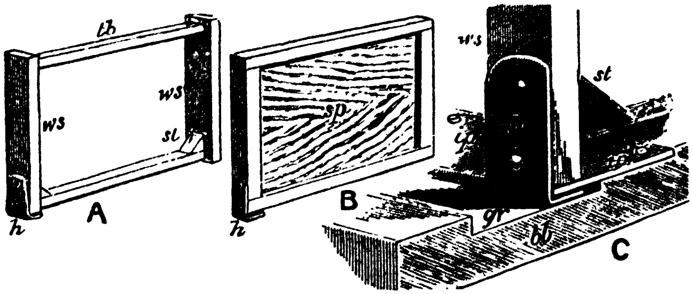
Along about that time came a general call for a frame that would have more brood to the comb. (See Comb Foundation, subhead Wiring Frames and Three-ply Comb Foundation.) As a good queen can more than fill an eight or ten frame Langstroth hive, it has become necessary to raise brood in the two stories. At the end of the heavy breeding period the brood-nest is reduced to one hive. It has been discovered that the queen will go into the second story more readily where thin narrow top-bars are used, but brace-combs are built in between. Notwithstanding this is true, the beekeeping fraternity prefers to avoid the nuisance of burr-combs, and therefore continues to use thick-top frames. If any change at all is made it will be along the line of the reduction of the thickness, leaving the width $1\frac{1}{16}$ as now. This is a matter, however, for the future to determine.

Whether a frame should be made reversible is discussed under the head of Reversing. Whether a frame should have the end-bars come in contact the entire length or only part way, or whether they should stand rather than hang, is discussed in the next subject.

FRAMES, SELF-SPACING.—By these are meant frames held at certain uniform distances apart by some sort of spacing device, forming either a part of the frame itself or a part of the hive. Under Spacing of Frames, elsewhere, and under Extracting, the distances that frames should be apart are discussed. Some prefer $1\frac{1}{2}$ inches from center to center; but the majority prefer $1\frac{3}{8}$ inches. Self-spacing frames are those that, when put into the hive, are spaced automatically, either $1\frac{3}{8}$ or $1\frac{1}{2}$ inches from center to center. Loose or unspaced frames differ from them in that they have no spacing device connected with them, and are, when placed in the hive, spaced by eye—or, as some have termed it, "by guesswork." Such spacing results in more or less uneven combs; and beginners, as a rule, make very poor work of it. The users of self-spacing frames get even, perfect combs, comparatively few burr-combs; and, without any guesswork, the combs are spaced accurately and equally distant from one another. Self-spacing frames are always ready for moving, either to an outyard, to and from the cellar, or for ordinary carrying around the apiary. Unspaced frames, on the contrary, while they are never spaced exactly, often can not be hauled to an out-apiary over rough roads without having sticks between them, or something to hold them in place.

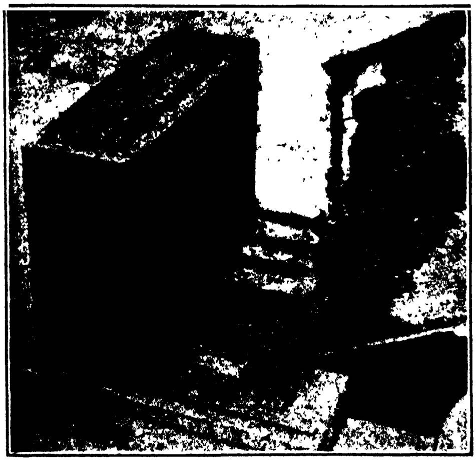
Self-spacing frames can be handled more rapidly. (See Frames and Manipulation of Colonies.) On the other hand, a few using the unspaced frame urge as an objection that the self-spacers kill the bees. This depends. The careless operator may kill a good many bees. If he uses a little care and a little patience, applying a whiff or two of smoke between the parts of the frames that come in contact, he will not kill any bees. The fact that some of the most extensive, if not the majority of beekeepers of the world, are using self-spacing frames, and the further fact that the number of users of self-spacing frames is constantly increasing and also, that all the bee supply manufacturers furnish them almost exclusively, show that this supposed bee-killing is more in theory than in fact. When frames are handled but two or three times a year, as is now the practice of some of the best beekeepers, all these objections lose their force to a large extent.

There are many styles of self-spacing frames. Among the earliest self-spacers were the closed-end Quinby. This, as its name indicates, is one in which the end-bars are wide their entire length. The top and bottom bars are one inch wide. These closed uprights, or ends, when they come in direct contact, cause the combs which they contain to be spaced accurate-



Quinby closed-end standing frame, showing the bottom corner.—After Cheshire.

ly from center to center. The above cut at A shows one such frame. All of the closed-end frames are made to stand, and have very often been called "standing frames." Mr. Quinby, in order to keep such frames from toppling over, invented the strap-iron hook on one corner, as shown re-engraved from Cheshire; *h* is the hook that engages the strap iron *ip* in the bottom-board; *gr* is a groove to admit the hook, and at the same time render it possible to catch under the strap iron, as shown in cut.



Quinby closed-end frame. This shows how the brood-nest can be split up or dissected for examination.

The combined end-bars make the end of the hive, and these hooks are therefore on the outside of the hive proper, and hence do not kill bees, nor are they filled with propolis as they would be if made on the inside of the hive. A and B are respectively the frame and the follower, although they are drawn somewhat out of proportion.

The ordinary closed-end frames come together laterally. The Quinby frames may be placed laterally up against each other; but the usual practice is to insert them from the end of the hive, sliding the end-bars past each other. The movement being endwise, it will shove all bees that may be on the edge of either of the frames aside.

The Quinby frame is a considerable departure from the Langstroth principle, because the Quinby hive and frame have no bee-space back of the end-bars. None is needed, for the reason the combined end-bars make the end of the hive; but the frame does have a bee-space above the top-bars and under the bottom-bars. Without the top and bottom bee-space, Captain J. E. Hetherington could never have handled 3000 colonies as he did in the 60's, 70's, and 80's on the Quinby frame for years in the Mohawk Valley, New York. P. H. Elwood was, up to the time of his death, using a large number of colonies on the same frame in Herkimer County, New York, and using them successfully.

With a panel on each side, a cover, and a bottom-board, the Quinby-Hetherington hive is complete, the ends of the frames forming the ends of the hive, although for additional protection in the spring the users have an outside case to set down over the whole. This makes a good hive that has many desirable features in it. For fuller details in regard to this frame and its manner of construction, the reader is referred to "Quinby's New Bee-keeping."

The Danzenbaker Closed-end Frames

A few people (and the number is getting smaller) prefer what is known as a "hanging frame," which has some advantages over the standing frame. The Danzenbaker is a closed-end hanging frame, likewise reversible. (See Reversing.) The

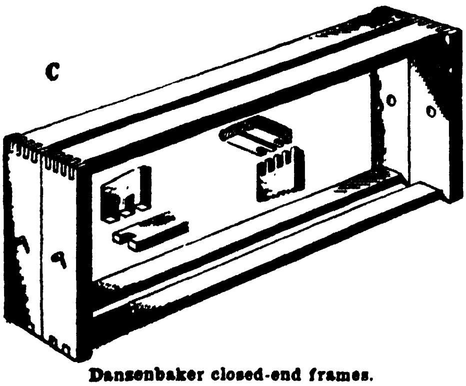
end-bars are pivoted at the center, the pins resting on hanger cleats secured to the ends of the hives. These pins make a very small line of contact, whereas the ordinary standing closed-end frame resting on tins secured to the bottom edge at the ends of the hive will crush some bees. The pins have the further advantage that, if there is any reduction in the depth of the hive due to shrinkage, the bee-space above and below the frames

The Quinby frames when placed together with a panel on each side are held together by a string wound once around and tied.

will be affected only half as much as if the frame were standing. These frames have practically gone out of use.

Improved Hoffman Frames

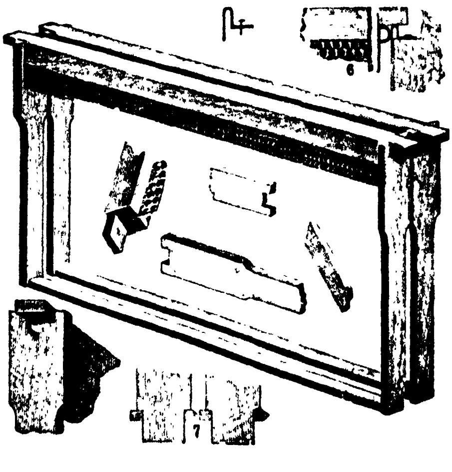
This is a modification of the original frame used by Julius Hoffman, then of Canajoharie, N. Y. The top-bars as well as end-bars had projecting edges at the ends; but as he used a special hive without a bee-space at the top, that construction was perfectly practicable. When the Hoffman-frame principle was applied to the regular Langstroth hive, with a bee-space on top, it was found that closed top-bars at the ends were impracticable because the bees went on top of the frames and glued the tops together and to the rabbets. In the Hoffman hives the bees were shut out from the tops, and, of course, could not stick the parts together. The modern Hoffman frames are, therefore, made having only the end-bars wide at the top. This greatly facilitates rapid handling, and preserves at the same time the essential feature of the original Hoffman by which it was possible to handle numbers of frames in lots of two, three, or four at a time, or space them all at one operation against the hive side. While the act may kill some bees, yet this can be avoided by blowing smoke down between the end-bars, and shoving the frames all together. In this respect the modified Hoffman has the great advantage over the original frame. This will be shown more clearly under Manipulation of Colonies.



Danzenbaker closed-end frames.

Why Short Top-bars

Another feature of this frame is the end-spacing staple that abuts against the



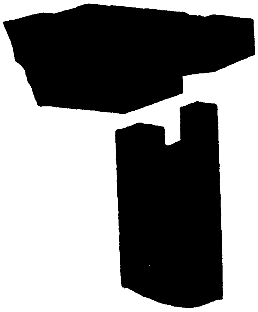
Old-style spacing of Hoffman frames.

tin rabbet shown. The ends of the top-bars are cut off so as to leave a bee-space around them. With the old-style frames the bees would glue the ends of the top-bars to the rabbet. This objectionable feature has been overcome in the styles shown here.

When the top-bar is long enough to reach and almost come in contact with the ends of the rabbets, the bees chink in bee glue between the ends of the top-bars and the rabbets. After the ends of all the frames have been thus glued it is somewhat difficult to remove any one comb, because the fastening of each frame must be loosened before the comb sought can be lifted out; but when the top-bar is shortened and the spacing end-hook is used there is none of this kind of gluing, the only fastening being that between the upright edges of the end-bars themselves; and this fastening for the majority of localities, so far from being a disadvantage, is useful in that it holds the frames together while the hives are being moved, and yet does not hold them so as to prevent easy handling.

Style of end-spacing hook used in 1930.

A difficulty experienced with the end-spacing hook shown above was that the frames when hauled over rough roads would sometimes hop out of position and off the metal rabbet at one end. To overcome this another form of end-spacer was devised, one that interlocks into the frame corner as shown below.



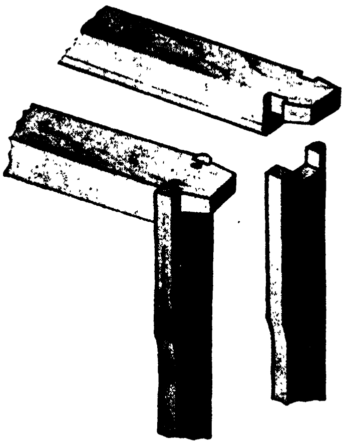
The new form of end spacer.

The top of this end-spacer slides into a groove at the top of the end-bar and the bottom hook drives into the wood lower down. This form of end-spacer interlocks with the notched corner when it is put together and is much more rigid than either of the other forms shown. It will not hop out of position over rough roads nor can the end-spacing be increased or decreased through pressure.

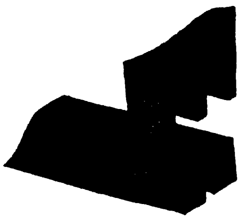
Lock-cornered Hoffman Frames

In 1927 the Hoffman frames were still further improved by notching and tapering the projections of the top-bars. When the fork of the end-bar is inserted in the notches, both vertical and horizontal, the frame is very greatly stiffened.

When nailed with two nails down through the top-bar down into the end-bars the frame can not get out of square without breaking away the notches and that is hardly likely. The end-bars at the bottom are double notched to receive the slot in the ends of the bottom-bar as shown in the illustration below. If one wishes to have the foundation extend through the bottom he can do this very nicely by using two narrow bottom-bars.



Root-Hoffman lock-cornered frame.



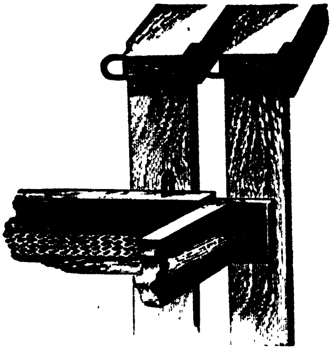
The notched corner keeps the frame rigid.

The Hoffman is the most extensively used self-spacing frame in all the United States, and there is even a possibility that it is used more generally than any other frame whether spaced or unspaced. All of the hive manufacturers supply it as a part of the regular equipment of their standard hives.

For details concerning its use, see Frames and Manipulation of Colonies.

Staple-spaced Frames

There are a few others who prefer frames with staples for side-spacers as here shown. Others use nails in place of



Staples used as side spacers.

staples; but the latter with their rounding edges allow the frames to slide past each other more readily.

Metal-spaced Hoffman Frames

All that has been said in favor of the regular Hoffman will apply with equal force to the metal-spaced frame here shown. In some localities where propolis is very abundant, sticky, or hard, the

Metal-spaced frame.

wooden projections of the regular Hoffman sometimes split off when the frames are pried apart. For localities where this condition prevails the metal spacer is recommended. It can be used interchangeably with the regular Hoffman. The spacers on this frame are stamped out of metal and must necessarily be accurate. The form of its construction in the shape of the letter U bending over the top-bar projection prevents the latter from breaking through careless handling.

Other Self-spacing Devices

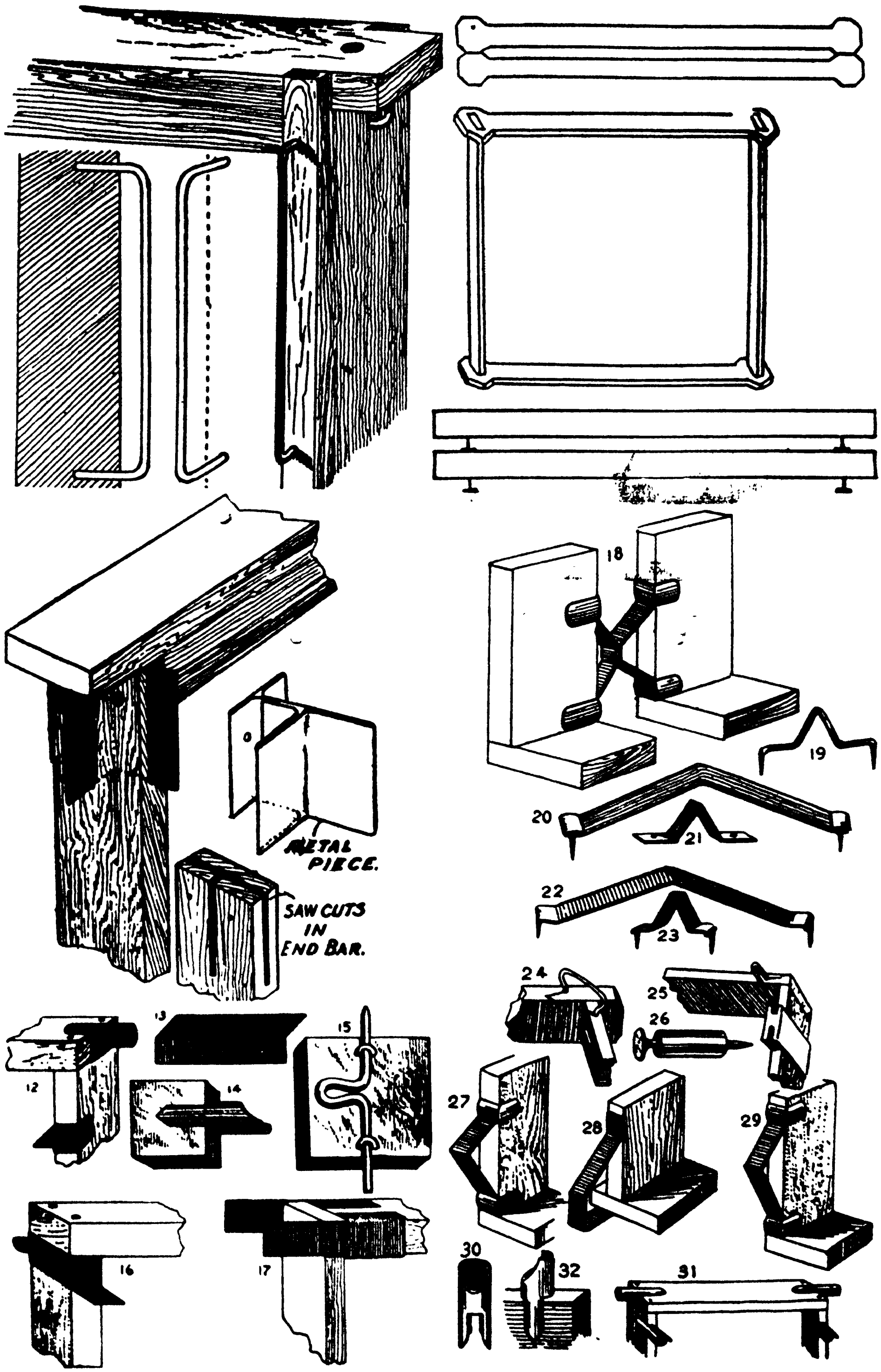
Various spacing devices have been suggested at different times. A few are presented on the next two pages, the reader being left to judge of their merits. It will not be necessary to describe them in detail, as the engravings make plain their manner of construction and use.

It will be noted that there are two kinds of spacing devices. One is made a part of the frame and the other a part of the rabbet. It would seem at first glance that the latter would be a very happy solution of the problem of automatic spacing, as it would leave the frames without projections in the way for uncapping; but the fact is, rabbet or hive spaces have never been very popular, and therefore are very little used. The principal objection to them is that one can not move the frames en masse or in groups, thus saving time in handling the brood-nest. The advantage of group-handling is made more apparent under Frames and Manipulation of Colonies.

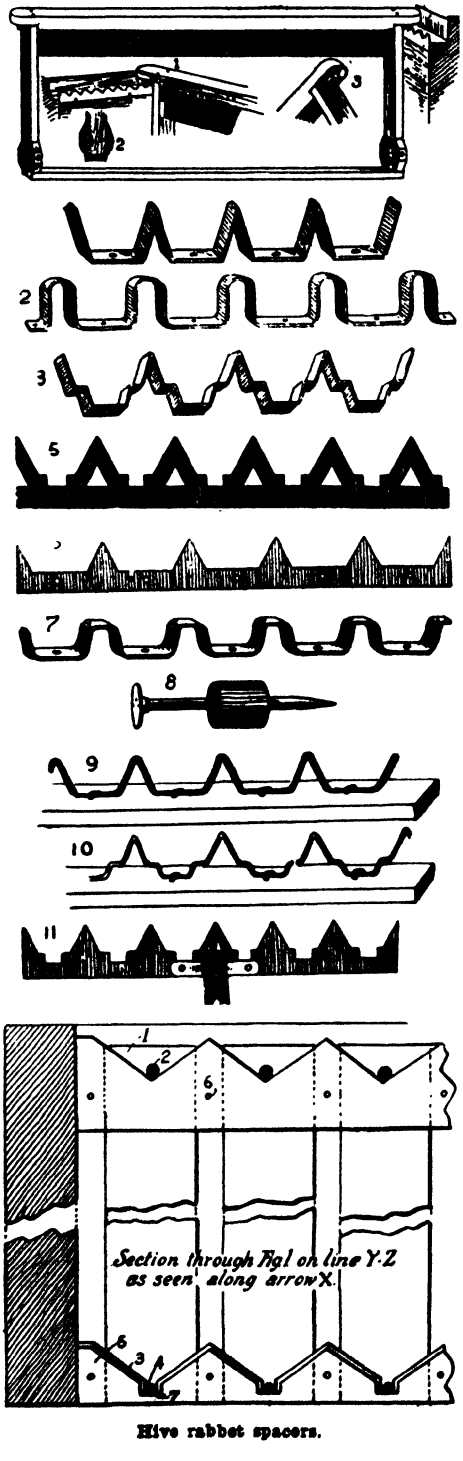
The very fact that no extensive beekeeper is using these self-spacing devices as a part of the hive or rabbet, and the further fact that all others who try them in a small way sooner or later abandon them, should discourage would-be inventors from wasting any time on them.

General Summary

Self-spacing frames make possible straight, beautiful, and regular combs; are practically free from burr-combs; can be hauled without any special preparation over the roughest roads, turned upside down, and rolled over without disturbing the combs. They permit, to a very great extent, the handling of hives instead of frames. Under Frames and Manipulation of Colonies is shown how frames can be handled in pairs and trios—in fact, half a hive at a time. They can also be inverted, thus causing the combs to be built out solidly to the bottom-bar; and, when once completed, they can be restored to their upright and normal position.



Various forms of frame spacers.



Hive rabbet spacers.

(See Reversing.) They can be handled as rapidly as the loose frame. Indeed the inventor, Julius Hoffman, of Canajoharie, N. Y., owner of some 600 colonies on Hoffman frames, said he could work nearly double the number of colonies with his frame that he could on any frame not spaced or close-fitting, and he had used both styles.

Self-spacing Frames for Small Beekeepers

Whatever may be said regarding the adaptability of Hoffman frames for the expert, it is evident that, in almost every instance, they are better for the beginner, average farmer, beekeeper, or any one who does not propose to make a specialty of the bee business, but desires to keep only a few colonies to supply himself and neighbors with honey. Such persons are apt to be a little careless, and, with ordinary loose unspaced frames, make bad spacing. It is seldom indeed that one can look into the hives of this class of beekeepers and find their loose frames properly spaced. In some instances the combs are so close together that opposite surfaces are gnawed down to give the bees sufficient space to pass between; and in others they are so far apart that small patches of comb are built between.

FRAMES, TO MANIPULATE.—See Frames and also Manipulation of Colonies.

FRUCTOSE.—See Honey.

FRUIT BLOSSOMS.—Filippo Arena, according to Dr. Frank Lutz, was the first man to take cognizance of the role of insects as pollinators. Arena's observations were recorded in 1763. Numerous observers through the intervening years have written on the subject, and few have failed to mention the honeybee as an efficient pollinator. California Experiment Station Bulletins 306 and 310, Oregon Experiment Station Bulletin 104, and Washington Experiment Station Bulletin 163 give in detail some of the results of experiments on the efficiency of the honeybee as a fruit pollinator. In addition to these scientific studies there is a great mass of favorable opinions and observations by fruit-growers all over the world.

There are several classes of fruit growers that for the purpose of this discussion may be divided into the following classes: (No. 1) those who do not know the value of bees and are honestly seeking infor-

Apple blossoms.

mation; (No. 2) those who have tried out a few bees in their orchards and see no apparent benefit from their presence; (No. 3) those who spray or dust their trees at the wrong time, killing the bees, and then wonder why they are of no benefit; (No. 4) those who know the value of bees as pollinators and wish to know when and where to get them, or whether they shall rent or buy; (No. 5) those who own bees and wish to know how to take care of them and get a crop of honey as well as of fruit; (No. 6) those who ignorantly believe that the doubtful good bees do is more than offset by the alleged damage they do in puncturing fruit or spreading blight among their trees.

The beekeeper has been furnishing colonies of bees too weak to get results in orchards and the fruit grower has not understood the conditions necessary for bees to do proper work in pollination in orchards. There have been disappointments and dissatisfaction on both sides.

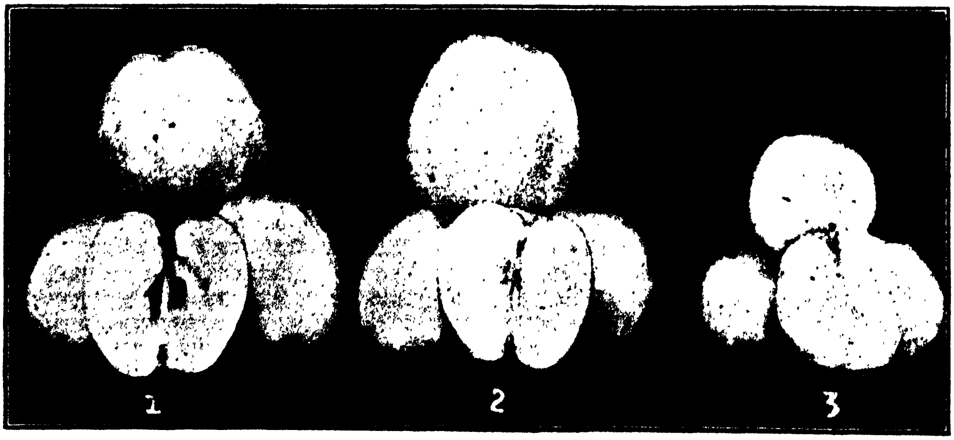
What is Meant by Pollination

Before these questions can be satisfactorily answered, a preliminary statement should be made regarding the general subject of pollination. It is derived from the word "pollen," the fertilizing element in all flowers so essential to the growth of seed and fruit and so necessary to give a balanced ration to the baby bees in a bee hive. Pollination means a transfer of

1. Self-pollinated Newton apples, producing at least one-third of the apples undersized. 2. Newton apples pollinated by Grimes Golden; no small apples.—(After Lewis and Vincent.)

the pollen from the male parts of the flowers to the female. Sometimes the male part is on one plant and the female part on another plant of the same species; but more often both the male and female parts are in the same flower. In a few cases the pollen of the same tree or plant can fertilize its own flowers. These are called "self fruitful." But in the great majority of cases the pollen must come from another tree or plant of the same kind before fertilization can take place. In these cases the blossoms are said to be sterile to their own pollen.

In many instances, the pollen is carried by the wind or rain from plant to plant, and sometimes it is carried by certain insects other than bees. But in the case of most fruit trees such as apple, peach, pear, cherry, plum, almond and citrus fruits, honey bees are almost the only agent for the transfer of the pollen. While other insects may do some of the work, they are not under the control of man, and there-



1. Keswick Codlin apple cross-pollinated; 2 and 3, self-pollinated. Notice the absence of seeds in the self-pollinated apples.—(After Lewis and Vincent.)

The 17-acre orchard that in its tenth year produced 6 carloads of apples with the help of the bees.

fore, are not often available. It has been proven that wind or rain has little or no value to transfer the pollen of fruit trees. It is, therefore, apparent that the fruit growers must use honey bees, whether wild or domestic, in order to secure the maximum results from their trees.

On the other hand, bees can not raise their young without what is called a nitrogenous food. This comes almost entirely from the pollen of flowers. Without this pollen, brood-rearing, and that means bee-raising, can not progress successfully, as there is no artificial substitute that will take its place. Old bees die off very rapidly and unless there is a constant accession of young bees the colony will soon go out of existence. Fruit trees must have the help of bees or other insects in order to bring about cross-pollination. Bees, on the other hand, must have the pollen that these very trees will furnish them. There is unmistakable evidence that bees increase the fruit crop; and it is for this reason that there is a very intimate and necessary relationship between the fruit grower and the beekeeper, as will be shown later.

No. 1—The Value of Bees, or How and Why Bees Increase the Fruit Crop

What is the evidence to show that bees do actually increase the quality and quantity of fruit, particularly of apples, pears, plums, cherries and the like? If one will critically examine the structure of the honeybee and the structure of the fruit blossom he will discover at once that the one helps the other. The correlation between the two is as striking as it is wonderful. The bees on the one hand are highly specialized with pollen-gathering apparatus in the form of fuzz or hair, all over their bodies, of serrated hairs on their legs, and of pollen-carrying appara-

Enlarged view of the honeybee, showing its hairy structure.

tus on their hind legs. On the other hand, it is apparent that the flowers of most of our fruits are made to entice bees. Apparently the flowers put out all kinds of inducements to attract their friends, the bees. Some are highly colored, others show little or no color but are rich with odor, nectar or pollen, or both. Sometimes we find, as in the case of fruit trees, color,

pollen and nectar, as well as odor. Some flowers even go so far as to put out convenient door steps to attract their visitors, as in peas and beans. This interlocking relationship is so marked that the reverent student of nature can hardly escape the conviction that the animal and plant kingdom, whether consciously or unconsciously, are working together in a friendly conspiracy for the benefit of both and for mankind. From the structural standpoint, what better proof could be advanced to show that the fruit trees need the bees and the bees need the trees, each carrying out its own end?

Fifty years ago, perhaps, it was believed that bees were of doubtful value in an orchard, but as the years go by the proof accumulates showing a most valuable work performed by them.

It is rather significant that there is not an experiment station in the United States that has not at one time or another mentioned the valuable and almost indispensable service performed by honey bees in orchards growing apples, pears, plums and cherries and in the growing of certain legumes, such as alsike and white clover, as well as sweet clover, cucumbers, etc. All eminent biologists from Darwin down to the present time have spoken in the highest praise of bees in orchards.

Honeybees Greatly Increase Set of Fruit

The question as to the role bees play in an orchard containing different varieties, says Ray Hutson of the New Jersey Experiment Station in Gleanings in Bee Culture, page 290, 1924, was attacked by enclosing two adjacent similarly cultured Kieffer pear trees, partially top-worked to Leconte, in separate insect-proof wire-netting cages floored wtih cheesecloth. In one of these cages a hive of bees was kept during the blossoming period; the other had no insects. After the end of the blossoming period the receptacles ("stems") of each blossom not properly set fell upon the cheese-cloth floor of the cages. These were collected and counted. The fruits set were also counted. The sum of these two counts is the number of blossoms. The number of fruits divided by the number of blossoms equals the percentage of set, a fair comparison. The results of this procedure are given in Table I.

TABLE I

	Blossoms	Set.	% Fruit
Trees with bees.. ..	8751	428	4.08
Trees without bees...	6479	7	0.1

A like experiment was tried on apples by enclosing adjacent similarly cultured apple trees of cross fertile varieties in insect-proof cages, having cheese-cloth floors. Two cages, each having in it a Wealthy and a Jonathan tree, were built.

Method of bagging a cluster of flower buds to determine whether the variety is self-fertile or self-sterile.—(After Lewis and Vincent.)

In one cage a hive of bees was kept during the blossoming period. The other was without insects. The comparison of the effect of the bees was secured in the same manner as with the pears, and is shown by Table II.

TABLE II

With bees	Blossoms.	Set	% Fruit
Wealthy ..	3475	591	17
Jonathan .	2758	288	8 2
Without Bees			
Wealthy	3675	148	4.08
Jonathan .	1985	16	0.8

During the cranberry blooming period a similar study was made on the cranberry. Honeybees are also effective pollinators for cranberries.

Scarcity of Other Pollinating Insects at Blossoming Time

These cage studies show that an abundant supply of bees during the blooming period will influence the set of fruit favorably. The question as to whether there are sufficient natural pollinating agents present at blossoming time was studied by systematic collections during the same period the bees were in the cages. Eleven representative collections covering about 40 acres of apple and pear orchard yielded a total of 876 insects. On the cranberry bogs two months later 450-500 bumblebees to the acre were

present. Calculations from these figures show that cranberries have a better chance for pollination without honeybees than apples or pears.

Experiments to Determine Best Distribution of Bees in Orchard

The effect of two methods of placing hives in the orchard was studied by counting the number of bees on trees at different distances from the hives under varying weather conditions. The first method studied was the common one of setting 10 to 15 hives down in the middle of an orchard. The counts made in a pear orchard showed that the bees spread from the hives over a circular area. Near the hive there were large numbers of bees. Fifty yards from the hive there were fewer bees, while one hundred yards away there were one or two bees to the tree. At the time the counts were being made, one was able to tell whether he was approaching or going away from the hives by the hum in the trees. The counts were made on several days, and each count showed that very few bees ventured beyond 100 yards from the hives under the weather conditions.

The results of the counts about hives

Mutual service.

indicate that a better distribution of bees results from scattering the hives placed 10-15 in the middle of an orchard more. When the bees were moved into the apple orchards, they were placed 4-5 hives in a place, approximately 200 yards apart. Counts made on trees about these hives in the same manner as in the other method showed that the areas covered by bees from these hives were approximately equal to the areas covered by bees from larger numbers of hives, although there were fewer bees per tree near the hives, as was to be expected. The areas covered by the bees of adjacent bunches of hives tended to overlap when placed at this distance apart.

Effect of Weather Conditions

A study of the data relative to the two methods warrants the conclusion that, as the hives are scattered the more thoroughly, the bees will reach every part of the orchard. During the time the counts were being made, the wind and temperature fluctuated, the former between 8 and 33 miles per hour. That the wind velocity is a factor in the distribution of bees from the hives is shown by a comparison of the counts on three days when the wind fell below 25 miles per hour. On the three days the wind was at 33 miles per hour only one or two bees to a tree were seen; on three days when the wind fell below 15 miles per hour an average of 17 bees per tree each day was counted. The same sixteen trees were counted each day in this average. The temperature during the period of the counts stood between 52° and 59° F.

These studies show at least three things: (1) Honeybees are an effective pollinating agent; (2) the insect population at blooming time is small; (3) weather conditions influence the flight of bees, making it necessary to scatter the hives rather than set them down in one place. The placing of bees in the orchard certainly gives a bigger crop and, it follows, larger returns; to secure maximum results all evidence shows that the hives should be scattered.

No. 2—Orchardists Who See No Benefit from Bees

For the benefit of those who have tried bees and find no apparent benefit from them, it should be said that there are many factors that have a bearing on this question. If the temperature at the time the trees are in full bloom is below 60 to 65 degrees, the bees will be unable to do much work on the blossoms. Their atten-

tion will be confined mainly to the trees nearest at hand. Those more distant will be neglected entirely. Should there be no warm days with a temperature lower than 60 degrees, the probabilities are that the bees can not get in their work. Likewise if it is windy, rainy or misty, the bees will be unable to fly.

The conditions mentioned are beyond the control of man. It is, therefore, important to have a large force of bees available so that if there be a few hours of good, sunshiny weather the bees can do their work.

Importance of Interplanting

But there are other factors which are in the control of man. The recent practice of planting fruit trees in solid blocks of one variety is a great mistake from the standpoint of pollination. Sometimes there will be three rows of one solid variety and then three rows of another variety. But unless these varieties are friendly to each other, that is, unless they are compatible so that the pollen of the one may pollinate the blossoms of the other no amount of bees could bring about results. No orchardist should put out his trees without first consulting his nearest experiment station. That station will tell him what varieties are best for him to grow on his soil and how to interplant the compatible varieties of apples, pears and peaches. Some varieties of fruits are self fertile but the majority of them are sterile to their own pollen. That means that unless they have help from another variety in the immediate neighborhood, no amount of bees will be able to bring about cross-pollination.

In Ohio the following is a list by the Ohio Extension Service of Ohio State University of the self unfruitful and a list of the pollinating varieties that may or may not apply in other states.

Self unfruitful apple varieties: Delicious (Richared, Starking), Stayman (Stamared, Blaxtayman), Winesap, Mammoth Black Twig, Paragon, King, Turley, Ohio Nonpareil, Rhode Island Greening. Except for Delicious, all these varieties are of no value in cross pollinating other varieties. Baldwin is of no value in pollinating anything but itself.

Apple varieties satisfactory for cross pollination: Ben Davis (Gano), Cortland, Delicious (Richared, Starking), Gallia Beauty, Golden Delicious, Grimes, Jonathan, McIntosh, Maiden Blush, Spy, Northwestern, Greening, Duchess (Oldenburg), Rome Beauty, Wagener, Wealthy, Winter Banana, Yellow Transparent, York Imperial.

Pollination with other fruits: With peaches, J. H. Hale is self-unfruitful. South Haven is an effective pollenizer. All varieties of plums benefit from cross pollination within each species (European, Damson, Japanese). All sweet cherry varieties should be considered self-unfruitful. Windsor is an excellent pollenizer for other sweet cherry varieties. Bing, Lambert and Napoleon are self-unfruitful, but pollenize other sweet varieties. Sour cherries bloom too late to pollinate sweet cherries. The Bartlett pear is self-unfruitful and cross pollination in pear plantings is advisable.

Where solid blocks of fruit trees have been planted, of varieties that are incompatible or sterile to their own pollen there are two remedies that can be applied. First and best is to top-graft some trees with some variety that will be compatible to the trees already in solid blocks. Top grafting, however, will take time before results can be achieved.

Bouquets of Pollinating Varieties

Immediate results for the season can be secured by the use of bouquets of flowers cut from compatible varieties of the trees of the right age of blossom. These can be put into tubs or in pails and placed between the rows of trees.

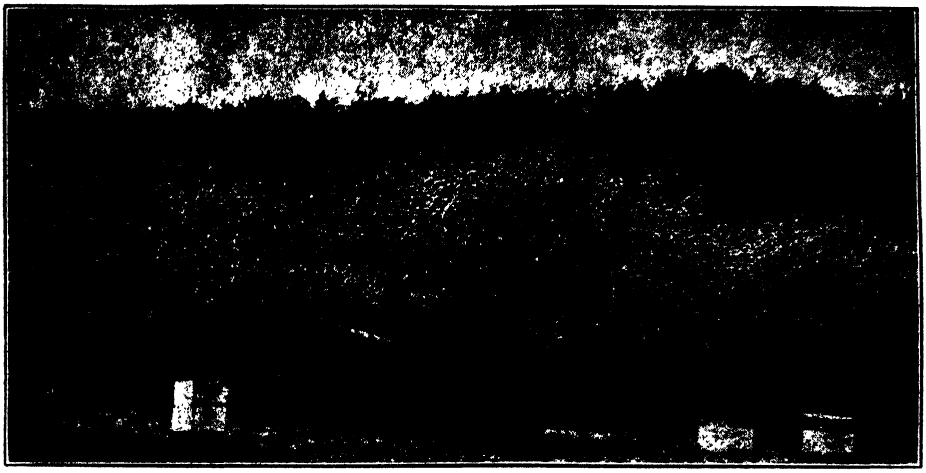
On this point H. D. Hootman, Secretary of the Michigan State Horticultural Society, and J. C. Kremer in the bee extension department of State College, East Lansing, Mich., have been gathering some interesting data in their state. In an article in Gleanings in Bee Culture, page 219, for 1930, they write:

"The hoped-for visits of the bee to 'tub bouquets' placed on the ground a few feet in front of the colonies in many orchards have often failed to give the results earnestly desired. This offered source of supply of pollen and nectar seldom tempted many bees to stop and investigate. The desirability of providing a convenient source of supply of pollen and nectar in this location often existed only in the mind of the person placing it there.

Proper Placing of Bouquets

"Realizing that the placing of the bouquet on the ground often defeated the object desired—namely, enticing the bee to visit the blossoms on its way to the field, a better method or one that called for the placing of the bouquets in the line of flight between trees was tried in a limited area in both a McIntosh and a Northern Spy orchard this past year. The 'set' of fruit in each case was increased from 10 to 14 per cent by using this method.

"On cool or windy days the bees show a preference for the blossoms on the sunny side of the trees. Unless the temperature is sufficiently high to induce the bees to



Elevated bouquets located in the sun between the trees were visited frequently by the bees.

fly freely around the tree the majority of the fruit set will be on the sunny side.

"When the bouquets were placed in pails of water and hung on tripods between the trees in the line of flight, the bees visited the blossoms of the bouquets as readily as those of the tree. When bouquets were suspended from a limb of the tree in the shade, and the weather was somewhat cool, the bees were disinclined to enter the shady area with the result that the bouquet did not prove entirely efficient in that position.

"Several counts made of the visits of bees to the bouquets in different positions under the same weather conditons revealed that the bouquets placed in the line of flight of the bee when it has begun its search for nectar or pollen received at least five times as many visits per minute as a bouquet in any other position."

For further information consult Bulletin No. 34, by Ray Hutson, which can be secured from the New Jersey Experiment Station, or Bulletin No. 404, Ohio Experiment Station, Wooster, Ohio.

Summary

It can not be too strongly emphasized that where orchards are set out in solid blocks of varieties sterile to their own pollen or inter-sterile to another row or variety nearby that no amount of bees can accomplish any results in pollination. They would visit the blossoms to get the nectar and the pollen, but there would not be pollination, and, of course, no increase in the amount of fruit. This is here stressed because many of the prominent horticulturists of the country have made this serious mistake.

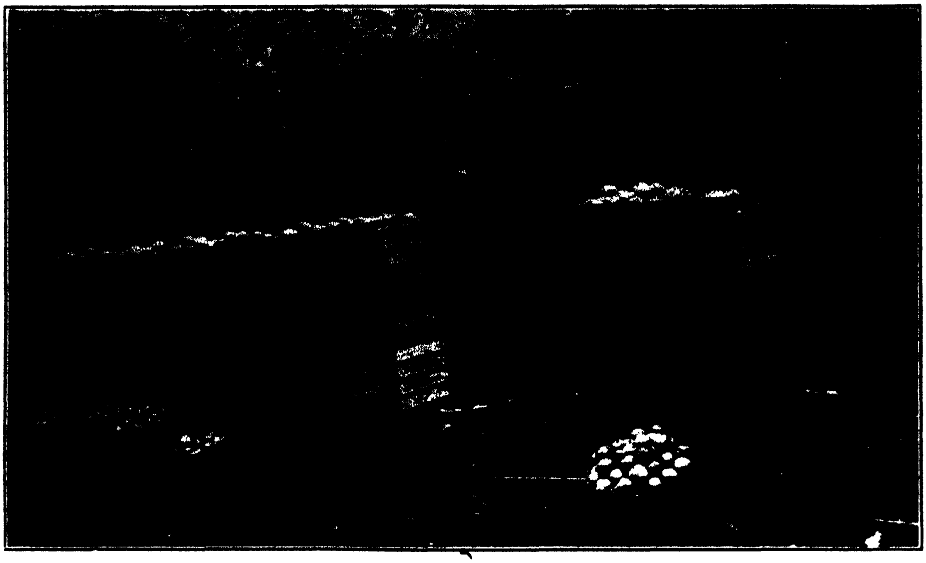
Colonies Too Weak to Accomplish Results in an Orchard

In early spring, at the time the fruit trees are in full bloom, colonies that contain only two or three frames of bees and brood will be of little or no value in an orchard, no matter if compatible varieties are placed near each other. Fruit growers should insist on strong colonies, hives that contain ten combs well covered with bees. Better results will be secured from two-story colonies containing 20 combs of bees with brood in eight or ten of the combs. On this point, see bulletin No. 190, by Dr. E. F. Phillips, published by Cornell University, Ithaca, New York, entitled "Honey Bees for the Orchard." Strong two-story colonies are several times more effective than the ordinary one-story.

Where it is not possible to buy or rent bees on combs in one or two story hives, the fruit grower will have to resort to package bees. He will require nothing less than a five-pound package, and generally it is better to have about two of them to the acre. See Nos. 4 and 5 further on.

No. 3—Spraying at the Wrong Time

In former years complaint was made that the fruit growers sprayed their trees while in bloom, and the practice is all too common now in spite of the fact that experiment stations everywhere have shown that better results can be secured by spraying before and after bloom. To apply the poison while the trees are in flow-



The 37 bushels at the left were picked from a Northern Spy tree in wh'ch cross-pollination was provided for at blossom time by placing 22 bouquets of Steele Red blossoms in the trees. The 10 bushels at the right were picked from a tree adjoining in which only three bouquets were placed.

er is a damage to the fruit grower and to the beekeeper alike—to the grower, because some of the delicate parts of the blossoms are injured, killing the embryo fruit; to the beekeeper, because the bees will be poisoned by thousands. It means killing the goose that lays the golden egg.

It should, perhaps, be explained to those who are not familiar with the general spraying proposition that two kinds of sprays are used by the fruit growers—one known as the dormant spray, such as lime sulphur or oil to destroy the San Jose scale, and the other a poison to kill the codling moth and other chewing insects that develop during the growth of the fruit. Lime, sulphur and oil are mainly applied to the trees during the dormant state, before they are in leaf or bloom, and are never harmful to bees. Indeed, they act as a repellant. The other spray, usually arsenate-of-lead solution, or Bordeaux mixture, or generally both, should be applied after the trees are out of bloom, or just as the last petals of the flowers are falling. If sprayed or dusted into the blossom, when the bees are gathering nectar, they are poisoned.

One of the best authorities in the United States on fruit-growing, no less a person than F. A. Waugh, author of the "American Apple Orchard," and in no way interested in bees or beekeeping, in Chapter III of that work, says:

"Special attention should be called to the fact that apple trees should not be sprayed while in blossom. Spraying at this time is not always totally without value, but in many cases it is not only unnecessary, but even highly dangerous to the crop. Under all circumstances it is very likely to poison the bees working on the apple blossoms. This sort of damage is far-

A good "set" of McIntosh was the result of having colonies of bees located in this McIntosh and Wealthy orchard.

reaching in many cases; and as the bee is one of the fruit grower's best friends we can not afford to murder whole swarms in this way."

Again, Prof. H. A. Gossard, former entomologist of the Ohio Experiment Station, Wooster, Ohio, writes:

"There is valid experimental proof that the bees are poisoned in large numbers by spraying with arsenicals when fruit trees are in bloom. There is also conclusive experimental proof that considerable bloom is killed if caustic poisonous sprays such as are commonly used near to blooming time are pumped on the open blossoms. I believe spraying during bloom causes greater financial loss to the orchardist than to the beekeeper, even if the swarms are destroyed. Self interest as well as a due regard for the rights of beneficent neighbors forbids that spraying of orchards be performed until after the bloom has fallen."

The most complete paper showing the destruction of bees by spraying at the wrong time is United States Department of Agriculture Bulletin No. 1364 by Dr. N. E. McIndoo and Geo. S. Demuth. The results of their work showed that when 90 per cent of the petals had fallen there was no loss of bees.

So far as known every experiment station in the United States advises against spraying or dusting while the trees are in bloom.

Dusting Often Destructive to Bees

In 1922 and 1923 many fruit growers began the practice of dusting their orchards with dry poisonous powder in place of using water in the form of spray to carry those same chemicals to the trees. A larger area of orchards can be covered with dust, and in less time, than by the use of liquid sprays; but much more chemical is required. But the dust carried by the wind falls upon the other bloom on which bees are working. Experience shows that hundreds of colonies were killed, and many hundreds of others weakened, in many states and particularly in New York in 1923, where the dusting method has become more or less prevalent. Bees were killed in New York in such numbers that beekeepers had to remove their bees from the vicinity of the orchards where dust was applied. It was hoped that some repellant might be used in connection with the poison dusts that would drive the bees away from the bloom; but nothing of that kind has been found. Some work was done by the Minnesota and the Connecticut Experiment Stations, showing that the dusting method for killing the codling moth is not so effective as the spray. Even some of the large fruit growers themselves are in doubt as to whether it pays to use it, and not a few are abandoning their dusting apparatus because the area of the dust can not be controlled. Sometimes dusting is wholly ineffective because the dust does not lodge where it will do good. Dr. H. A. Surface, formerly State Zoologist of Pennsylvania, has stated that dusting is not as efficient as spraying.

The difficulty is that the dust is carried everywhere by the wind, and unless the foliage is wet with dew or rain it is blown into the air. The dust may fall on the cover crop; and when it consists of any of the clovers it may fall on blossoms that are just in the height of the nectar secretion and upon dandelion blossom in or near the orchard. Bees gather this poisoned nectar and die by the thousands. The dust may be carried hundreds of yards in all directions. Even though the bees may not be working on the clover blossoms they may take up the morning dew from the grasses and plants that have been dusted previously with arsenical mixtures. When the spray is used the effect is local, and only on trees that are out of bloom.

As a rule, it is much safer to move the bees from the orchard entirely when arsenical poisons are applied either in the form of a liquid or dust. If the orchardist will take the proper precaution to apply the dust when there is little or no wind in the early morning when the dew is abundant, and if he will wait until the petals of the flowers have fallen and no other nectar-bearing flowers are in or near the orchard, no bees will be killed. Dusting machines are not here condemned when used at the proper times.

It should be stated that neither dusting nor spraying lime sulphur alone will do any harm to the bees, as the lime sulphur is not poisonous, and, what is more, the bees will not go near trees that are not in bloom. During the dormant season the trees will be sprayed to kill the San Jose and oyster-shell scale on the bark, and, of course, there will be no bloom then.

Conclusion: From the foregoing it is plainly apparent that bees can not do much good in an orchard if the spraying or dusting is applied at the wrong time.

No. 4—Where to Get and Where to Place Bees for Orchard Work

When there are single orchards of not over three or four acres in size, the bees in the neighborhood may be sufficient to take care of the trees when they come into bloom; but when orchards reach the size of from five to ten, fifty or one hun-

dred acres or more it is necessary to restore the balance of nature by putting enough bees into the entire area covered by the trees, to do the work of pollination. Usually a colony to the acre of mature trees, if the colony be strong, is considered enough bees to do effective work. If the trees are ten or fifteen years old half that number will be sufficient. Where they are only four or five years old, one colony will take care of four or five acres. But it should always be understood that a colony should be strong. (See close of discussion under No. 2.)

Importance of Scattering the Bees in an Orchard

It is important to emphasize again that the number of colonies should not be placed all in one place, but scattered over the entire orchard. Unless this is done some seasons it is noticeable that there will be a heavy fruitage in the vicinity of the orchard where the bees are placed, and a gradually diminishing fruitage as the distance increases from the bees. If the weather be too cool, as it often is, bees will visit only the nearest trees. By placing the hives or package bees approximately 200 feet apart, the work of pollination will be evenly distributed.

If steady, warm weather could be depended upon when the trees come into bloom it would not be so necessary to scatter the bees, but as a rule, in early spring the weather will be changeable, possibly the sun coming out only a few hours, and it is then that the bees must get in their work and the colonies must be strong. If they do not have to fly too far they will pollinate the trees thoroughly within a range of two hundred feet.

Again, Hootman and Kremer have some valuable information on the placement of bees in orchards. We quote again from their article on page 220 for 1930, in Gleanings:

"Bees Double Fruit Crop

"For pollination purposes the importance of distributing the colonies through the orchard during the blossoming period must be carefully considered. The experience this past season of Frank Street, manager of the Kentucky Cardinal Orchards of Henderson, Kentucky, well illustrates this point.

"On the strength of facts brought out in a recent pollination publication he placed 50 colonies of bees in a 45-acre tract of Winesaps, in which the pollinating variety was Champion, this variety being planted every third tree in every third row. The bees were placed about ten feet away and facing the pollinating variety.

"They had two other tracts of orchard of about equal producing capacity located six and eight miles from the orchard under discussion. The following are the harvesting records on these three orchards from September 15 to October 15. The varieties in the main are Winesap, Stayman, Delicious, Ben Davis and Champion.

"The bees were distributed in the Green Farm Orchard at the rate of about one colony to the acre as indicated above. The other orchards were situated near colonies of bees, but no bees were placed directly in the orchard. The Park Orchard on which the pollination appeared the poorest was within 2000 feet of a commercial apiary, but the bees had to cross a wind-swept valley to reach the orchard. Rain and high winds interfered with their normal flight during the bloom.

Farm.	Hand picked	Drops.	Total bu.
Park Orchard	5,661	3,800	9,461
Home Farm	5,839	3,060	8,899
Green Farm (bees)	14,381	2,872	17,253

"In the table above we would like to call attention to the fact that from pollination the number of bushels of drops or ground fruit was not only reduced but the total yield was nearly doubled. Did it pay to distribute the colonies through the orchard?

Location in Orchard Important

"To assure sufficient insect activity under adverse weather conditions at blossoming time, strong colonies of bees should be distributed in mature orchards at the rate of about one colony to the acre. Bee flight will be encouraged and better results obtained by locating the colonies in sunny wind-sheltered locations, away from exposed locations swept by strong winds. When wind is blowing over 20 miles an hour, cross currents and eddies are created among the trees which are avoided by the bees. These conditions are unfavorable to the bees, and their flight under such conditions is greatly reduced.

"Distributing the colonies through the orchard will provide for the most economical utilization of any flight that is made for pollination purposes; the place for the colonies during blossom time is in or very near the orchard, not in an api-

ary a half mile or more from the orchard."

Where to Get the Bees

The next question is, where and how to get the bees. If there is a local beekeeper in the vicinity, one who will have strong colonies at blooming time, not weaklings, arrangements can be made either to rent or buy the bees. The author recommends renting with the understanding that the spraying and dusting are to be done when no flowers are in bloom in the orchard. In case of the smaller orchards, it has been customary to rent one-story colonies of full strength, at the rate of \$2.00, \$3.00 or even \$5.00 a colony. Usually a beekeeper, if he brings strong colonies, can not afford to move them into the orchard and then out again for less than \$5.00 per colony. The amount of nectar or honey that the bees will get from the fruit trees, will, as a rule, be negligible. If there could be nice, steady warm weather during the entire period when the trees are in bloom, the bees might gather enough honey to recompense the beekeeper without any compensation from the fruit grower. When bees are rented or purchased for the work of pollination, fruit growers should always stipulate that the colonies should be strong. That means that every comb should be well covered with bees. It would be far better to have the colonies two-story, bees in both stories. If the work of pollination is confined to just a few hours a strong colony will do much more effective work than a weak one in the same given time.

No. 5—Buying Bees Rather Than Renting

In some cases it is advisable and certainly cheaper to buy the colonies outright. The fruit grower would then have to be a beekeeper or become one in order to give them intelligent care at the right time. With the literature now available on how to handle bees, this should not be difficult, for it takes no more skill to take care of bees than it does to run a fruit orchard, or, to put the proposition another way, one who is able to make a success of growing fruit would also be able to make a success of keeping bees. If he puts the bees first in his fruit orchard, then sprays and dusts at the right time, it would be better to own the bees.

It is a very nice arrangement for a group of orchardists in a vicinity to buy bees, keep them permanently, and employ a competent beekeeper to look after the bees of all the orchards. In other cases the orchardist is such an extensive grower that he can afford to run the bees and his orchard both at the same time, and employ a competent man the year round. When the bee man is not at work upon the bees, he can do work in the fruit orchard, letting the bees shift for themselves during that time. This is being done very successfully in many cases.

Five-pound orchard packages scattered throughout the orchard, two packages to the acre, do a good job of pollination. The wire cages of bees should be wrapped in waterproof paper as here shown to protect them from the weather.

Several of our colleges and universities have courses in bee culture. The students taking this work are trained not only in the care and management of bees but are given special instruction on how to make the bees effective in orchard work. Cornell University, Ithaca, N. Y., the University of Wisconsin, Madison, Wis., Ohio State University, Columbus, Ohio, and Michigan State College, East Lansing, Mich., especially can furnish such students.

Package Bees

There are a large number of localities where there are extensive orchards, so extensive that the wild bees and occasional bees owned by beekeepers are wholly inadequate to do the work of pollination. In such cases the orchardist may buy swarms of bees in cages without combs that can be sent from the South to the northern orchards by express. At one time it was believed that a two or three pound package would be adequate; but later work shows that the five-pound size, containing approximately 25,000 bees, is

much more effective than a two or three pound package. In a number of instances where there are no bees in the vicinity it would be much better to have two five-pound packages to the acre. The order for

Orchard packages are covered with building paper and the cage thus made to serve as a hive during fruit bloom.

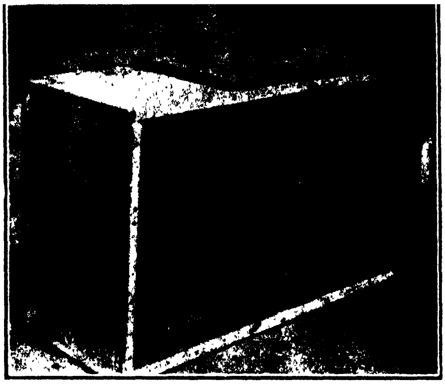
these bees should be placed at least ten days or two weeks before the trees are expected to be in bloom and it should be clearly stipulated that the bees will be of no value whatever unless they are on the ground in the orchard by the time the first bloom comes out. It is for this reason that the orders should be placed with men who have a reputation for reliability and prompt delivery of bees on schedule time. The publishers will be glad to furnish a list of such breeders to any orchardists asking for the information. The price of these combless swarms will be only a little more than rental price of strong colonies, but are not as effective.

The wire cage containing the bees will usually have enough sugar syrup to take care of the bees until the trees come into bloom. If not, they should be fed a sugar syrup, as directed in the little pamphlet on package bees that the publishers will be glad to send on request. Each one of these packages on arrival should be wrapped in a waterproof paper or tarred paper, and then distributed throughout the orchard, about an equal distance apart. After being placed the entrance cork should be pulled to allow the bees to fly.

A five-pound package of bees is not the equal of a strong colony but equal to most rental colonies. To be on the safe side the author recommends two five-pound packages to the acre, providing the trees are from twenty-five to fifty years old. In the case of young orchards, a five-pound package to the acre would be very ample.

At the end of the season, or after the trees are out of bloom, they should be moved from the orchards and placed with some beekeeper. If this is not possible the bees should be burned. Most state laws require that bees shall be kept free from disease, and the average fruit grower, unless he studies up on the subject, would better destroy them. If, however, he is willing to study up on the subject, he can put these package bees after they have done their work in the orchard into regular hives, equipped with frames and comb foundation.

It seems like a waste to destroy package bees and if the orchardist doesn't



A package of bees from the South ready to be wrapped in paper to exclude rain and weather.

care for them after pollination he perhaps could get someone who would be willing to do the work, place the bees in the hives and have them ready for next season's work.

There are bee disease laws in nearly all of the states and any bees that are left by themselves not on combs would probably be destroyed by the state bee inspector, unless otherwise disposed of.

No. 6—Bees Not Guilty as Charged

There are a few who believe bees do more harm than good. The attempt has been made to prove that the bees have been the means of scattering pear blight or fire blight on apple trees. The "evidence" against the bees at best is incomplete and inconclusive. There have been a large number of experiments conducted to determine this matter and it has been shown that bees have little or no part in the spread of pear blight, twig or blossom blight. This blight is a bacterial disease that attacks the twigs and the ends

of the branches. If not checked, it may extend to the entire branch or tree. In the spring the affected limbs exude a gummy substance filled with germs called "holdover cankers." It has been definitely proven that flies, ants, aphids (or plant lice), leaf hoppers and certain other bark-piercing insects in connection with rains are the means of carrying this blight. It has been observed that when the plant lice are abundant, fire blight is most prevalent. It is also proved that bees will not visit blighted blossoms, although they will visit freely the healthy ones on the same tree. (See Fire Blight.)

J. H. Merrill, formerly of the Kansas Experiment Station, Prof. H. A. Gossard, Wooster Experiment Station, and Prof. A. L. Pierstorff, plant pathologist, Ohio State University, have conducted experiments showing that bees are not the means of scattering blight. (See Fire Blight.)

In brief: Fire blight appears both before and after pear and apple trees are in bloom, and it is well known that bees do not visit the trees except for nectar and pollen; the germs of blight must be pricked into the tender tissues of the limb and honeybees have no means of puncturing or piercing the bark; experiments show conclusively that fire blight can be and is spread by hosts of sucking and biting insects, and not by bees.

Bees Falsely Charged with Injuring Fruit

The statement has been made that bees can cut into ripe or sound fruit; but the facts of recent years have disproved this. In two or three cases, where the matter has been referred to the courts, the bees have been declared not guilty. The most celebrated case of the kind was that of Utter vs. Utter that took place at Amity, N. Y. The jury was unanimous to the effect that bees do not puncture sound fruit.

Bees have sometimes been accused of puncturing grapes; but careful examination shows that small birds with sharp beaks, conspicuously the Cape May warbler and the Baltimore oriole, pierce the grapes. The small, sharp, needle-like holes left in the berries are visited by the bees during the day, during which they suck out all the pulp, leaving nothing but the shriveled skins. The bees get the credit of doing mischief that the birds have actually made possible. For information on this subject refer to the United States Department of Agriculture, Washington, D. C. (See Bees as a Nuisance.)

Bees will sometimes visit overripe fruit that has cracked open, or partially decayed fruit. They work over such fruit during a scarcity of nectar, sucking out the juices, and leaving only the mere shell of the fruit. Some fruits of this kind have a market value; and when the bees help themselves to them in a wholesale way, as they sometimes do, where damage has been done, the owner of the bees should remove them temporarily (just before the fruit ripens) or reimburse the fruit grower.

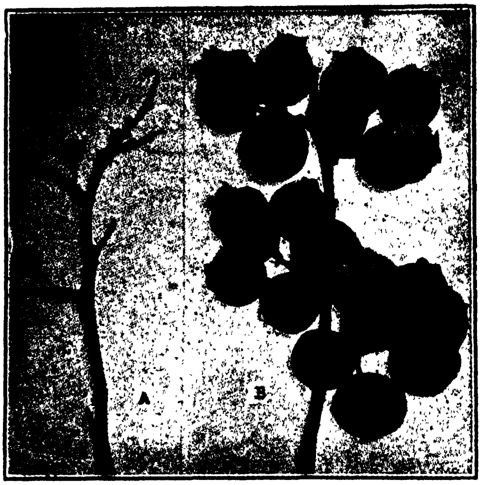
At the eighth annual meeting of the Pennsylvania State Beekeepers' Association, held in Harrisburg, Pa., January 22, 1910, Dr. H. A. Surface, president of the Association and former State Zoologist of Pennsylvania, exhibited two trays of grapes that he had placed in empty supers within his bee hives a month before. One contained grapes, each of which had been pierced by the smallest needle point, and the other contained grapes ripe but unpierced.

Those that had been pierced had been so completely sucked out that only the skins and seeds remained, while those unpierced had dried just like raisins, with all their dried pulp present and undamaged. This proved that bees can not and do not pierce grapes to get their juice, and that they can attack them only when they have been injured previously.

Summary of Opinion of the Value of Bees in Fruit Orchards

The editors of the various fruit journals, among them "The Fruit Grower," of Rochester, N. Y., and "Better Fruit," Hood River, Ore., have a number of times published strong editorials in favor of putting bees in orchards. Among the leading agricultural journals is the "Rural New-Yorker," whose editor makes the following statement: "I have seen the certain results of the good work of the honeybee in a neighbor's orchard. Those bees break the trees down just as truly as though they climbed on the trees by the million and pulled on them. The appearance of those trees after a few years of beekeeping would have convinced any fair-minded man that our little buzzing friends are true partners of the fruit-grower."

Practically all bulletins from the various experiment stations and from the Department of Agriculture, Washington,



A. Self-pollinated blueberries. B. Cross-pollinated blueberries. These two twigs (reduced one-half) bore the same number of flowers, and were pollinated at the same time by hand. But A was pollinated with pollen from other flowers on the same bush, and B with pollen from another bush. The self-pollinated flowers produced no ripe fruit, all the berries that set remaining small and green and later dropping off; while the cross-pollinated flowers produced a full cluster of large berries. A plantation made wholly of cuttings from a single bush would produce little or no fruit. (From Coville.)

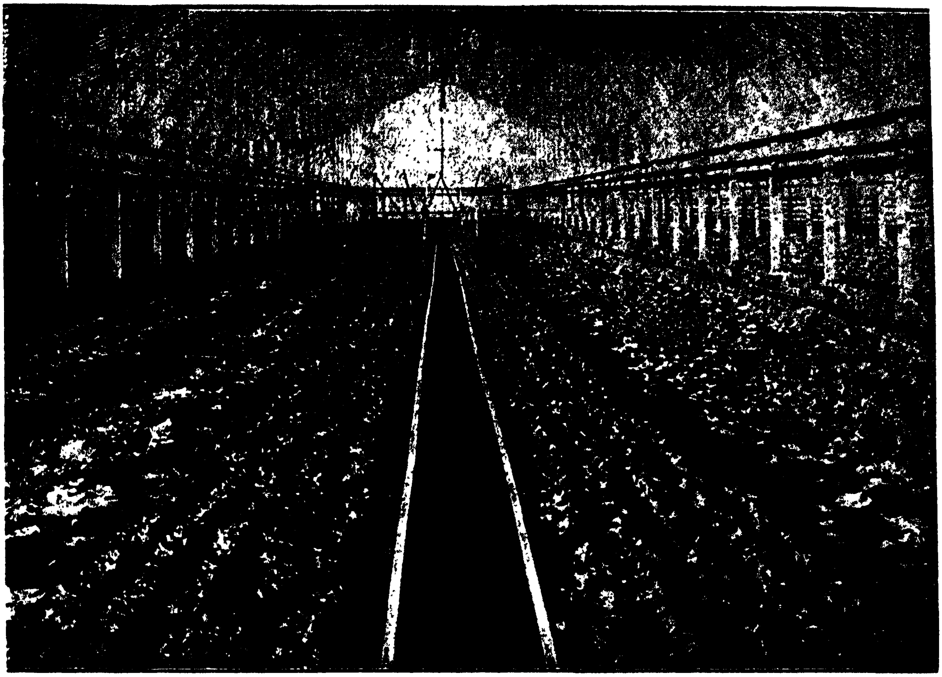
D. C., show conclusively that the bees are necessary to secure the maximum results, both in quantity and quality of fruit. A fruit grower and a beekeeper should secure one or more of these bulletins. A careful reading will convince the most skeptical of the value of bees in orchards.

Nearly all varieties of apples, pears, quinces, plums, sweet cherries and grapes are benefited by the presence of bees. Sour cherries and most peaches, except the Hale, are to a large extent, self-pollinating; but even they are helped by bees some seasons when the weather conditions at the time of bloom are bad. The H. J. Hale peach certainly requires the agency of bees to insure a crop. While the orange is to a certain extent self-pollinating, it, too, according to growers in Florida, has fewer "drops" when there are plenty of bees. Orange growers in Florida invite beekeepers to put bees in the vicinity of their orchards. In an off year when weather conditions are not favorable plenty of bees will help materially to keep up the crop average. (See Gleanings in Bee Culture page 474, for 1933.)

Cucumbers in green houses and elsewhere certainly depend upon bees. Without bees the crops are light and cucum-

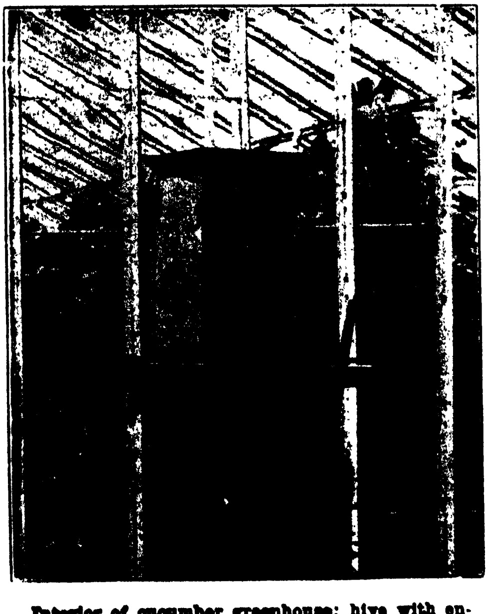
Bing sweet cherry crossed by Napoleon yields no fruit.—(After Gardner.)

Average cluster of Bing crossed by Williamette.—(After Gardner.)



One-half of the great glass building at Ashtabula, Ohio. Cucumbers are replacing the lettuce and there are thousands of the golden yellow blossoms yielding to the bees their pollen and nectar. Many of the blossoms are visited by two or three bees in five minutes. The results show that the cucumbers are not only more perfect in shape but that the crop is much larger.

bers themselves are deformed and ill-shapen.



Interior of cucumber greenhouse; hive with entrance inside.

While nearly all the bulletins that have ever been issued on the growing of fruit have spoken favorably of bees, the following should receive special mention. Usually a copy of the bulletin in question can be secured for the mere asking, if in the same state. If not, a charge of from 5 to 10 cents is asked.

Bulletins Nos. 306 and 307 on the pollination of both the Bartlett pear and the almond, by W. P. Tufts, of the College of Agriculture, University of California, is most convincing. Bulletin No. 274 from the same college gives invaluable evidence showing the excellent work done by bees in the great prune orchards of California.

"Cross Pollination of Apples," by N. B Waite, Year Book, Department of Agriculture, 1898; "Pollination of the Apple," by C. I. Lewis and C. C. Vincent, Oregon Experiment Station, Bulletin No. 104, 1909.

Beach, S. A. The fertilization of flowers in orchards and vineyards especially in its relation to the production of fruit. 13th Ann Rept. N. Y. Agr. Exp. Sta. 633-648. 1895.

Fletcher, S. W. Pollination in orchards. Cornell Agr. Exp. Sta. Bul. 181:335-364. 1900.

Hendrickson, A. H. The common honey bee in prune pollination. Cal. Agr. Exp. Sta. Bul. 291: 213-236. 1918.

Waugh, F. A. Report of the Horticulturist. The pollination of apples. 13th Ann. Rept. Vt. Agr. Exp. Sta. 1899-1900-312-316. 1901.

While these bulletins are somewhat old, no better work has ever been done by any-

1. Brighton grape self-fertilized; 2, Brighton grape cross-fertilized.—(After Beach.)

one in more recent times, and they are worth reading. The following are some of the later bulletins and are especially convincing:

"Honey Bees for the Orchard" is the title of Cornell Extension Bulletin No. 190, by Dr. E. F. Phillips of Cornell University. From the standpoint of the beekeeper and the fruit grower this is one of the most informative ever published.

Bulletin No. 577 of the Geneva Experiment Station, New York, concerns itself with the self and the cross incompatibilities found in the apple, pear, cherry and plum.

"Pollination of Orchard Fruits in Michigan," Bulletin No. 188, by Roy E. Marshall, Stanley Johnston, H. D. Hootman and H. M. Wells deserves special mention as it shows the value of bees in bringing out pollination of various fruits. Published by Michigan State College, East Lansing, Michigan.

"Pollination of Deciduous Fruits by Bees," Circular No. 62, by G. L. Phillip and G. H. Vansell, is another excellent bulletin showing what bees can do. Published by the College of Agriculture, Berkley, California.

Bulletin No. 497, entitled "Pollination and Other Factors Affecting the Set of Fruit," goes into the subject of the pollination of fruit exhaustively. Regarding bees, it says: "The honeybee is credited with about 90 per cent of the pollen transfer in orchards." Published by Agricultural Cornell Experiment Station at Ithaca, New York.

"Relation of the Honey Bee to Fruit Pollination in New Jersey," Bulletin No. 34, by Ray Hutson, gives some fine experimental work that proves all that has been said in the preceding pages. It is a bulletin of exceptional merit.

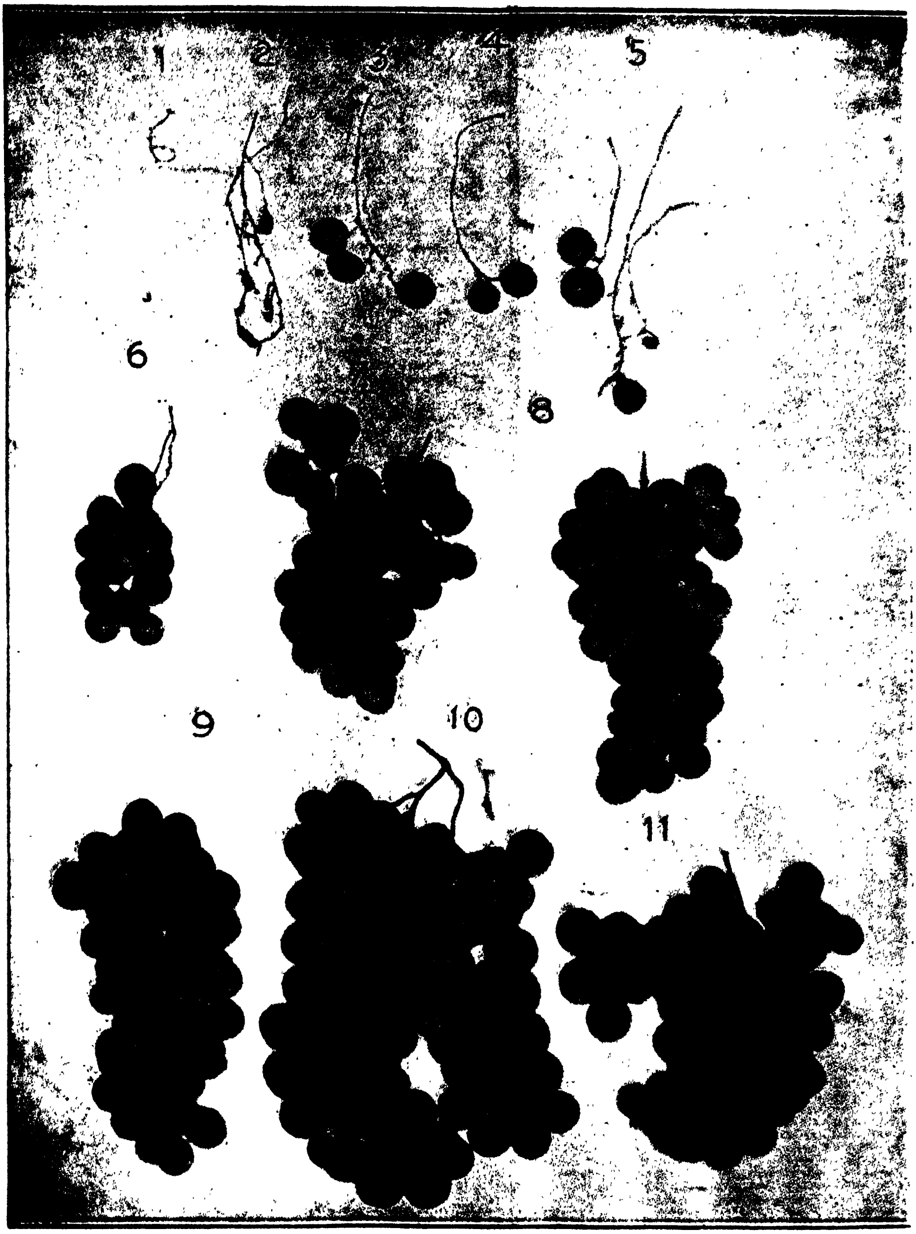
Prof. E. C. Auchter, of the Department of Horticulture, University of Maryland, especially has given some most valuable testimony for the bees. Auchter is one of the greatest authorities on fruit culture in the United States.

"Apple Pollination Studies in Ohio," bulletin No. 404, Ohio Agricultural Experiment Station, Wooster, Ohio, shows the value of mixed plantings.

Alderman, W. H., Experimental work on self-sterility of the apple. Proc. Amer. Soc. Hort. Sci. 1917. (14):94-101. 1918.

Cucumber blossom with a bee on it; caught in the act.

In a remarkable statement by Albert Repp, of Repp Brothers, owners of an 800-acre fruit farm at Gloucester, N. J.,



Brighton grape pollinated by 1, Salem; 2, Creveling; 3, Lindley; 4, pollen of another vine of same variety; 5, self-pollinated; 6, by Nectar; 7, Jefferson; 8, Niagara; 9, Worden; 10, Vergenes; 11, Rochester.—(After Beach.)

he says: "I could not do without bees. I never take a pound of their honey. All I want them to do is to pollinate the blossoms. I'd as soon think of managing this orchard without a single spray-pump as to be without bees. I've got 50 colonies now and am building up each year."

It is the unanimous opinion of all progressive fruit growers that honeybees and fruit culture are inseparable. (See Pollination.)

FRUIT INJURED (?) BY BEES.—See Bees, subhead, Do They Injure Fruit?

Gallberry (Ilex glabra.) Photographed by J. J. Wilder.

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GALLBERRY (*Ilex glabra*).—Inkberry. Evergreen winterberry. This is a small evergreen shrub that has minute white flowers that develop into small black ink-like berries with smooth skins—about the size of buckshot. They taste very bitter—"bitter as gall," hence the name gallberry. By the ignorant colored folks they are considered good for the stomach, but they probably have little medicinal value.

Gallberry is one of the most important honey plants of the southeastern states, along the Coastal Plain. It is at its best in Georgia, where it supports a large number of apiaries.

The honey is white, of good flavor and body, and when not mixed with titi (see Titi), it is not unlike a good grade of white clover. Were it not difficult to get it free from other honeys, it would be excellent for the bottle trade in the North because it so greatly resembles clover honey. As it is it finds a ready market. When mixed with tupelo or black gum it makes a fine table honey.

J. J. Wilder believes gallberry would support many more bees and beekeepers than it does.

For further particulars see "Honey Plants of North America."

GLOVES FOR HANDLING BEES.—Although a good many apiarists work with bare hands and bare wrists, there are a few who prefer to use gloves with long wrists, and quite a large number who use them with fingers and thumbs cut off. If the bees are hybrids, and extracting is carried on during the robbing season, or if there is a sudden stoppage of the honey flow, it is a great convenience to use something that protects the back of the hands and wrists, leaving the fingers bare, so that, for all practical purposes of manipulation, one can work as well with protectors as without. There are times when even the gentlest bees are so cross that something to protect the hands and wrists saves a painful lot of punishment from stings. At such times bee veils are a necessity. (See Anger of Bees, page 34, and Bee Behavior, page 63, and Stings.)

Women beekeepers and men who are at all timid, and a very small number who seem to be seriously affected by even one sting, can use gloves to great advantage.

A very good glove for working among bees is one made of kid or dogskin. While the sting of a bee will often puncture the former, one does not get much more than just the prick of the sting. By removing the glove, the sting is removed automatically.

Then there is a kind of glove, shown in the illustration, made of heavy drilling that fits the hand loosely. Tight fitting gloves do not prevent the stings from piercing through to the skin. The buckskin gloves are sting-proof. After one becomes more familiar with handling bees, he can cut off the finger tips so that the fingers actually come in contact with the frames. One can work better when he can feel as well as see what he is doing.

For further particulars regarding bee-dress, see Veils.

GLUCOSE.—This name is applied to the thick viscous liquid obtained by the concentration of a solution coming from the incomplete hydrolysis of starch. The word is misapplied by a great many, especially in the sugar-cane belt, for the reducing sugars present in the cane. From a purely chemical side, glucose means the sugar dextrose, so with these various ap-

plications of the word some little confusion exists. In the commercial world, however, the first is the accepted meaning of the word. In the United States the source of glucose is cornstarch, but in Germany all is made from potato starch.

Its manufacture consists in the heating of the freed starch with water and a small percentage of hydrochloric acid under pressure. The process is carefully conducted and stopped at the proper point of hydrolysis. The liquid is neutralized with soda and concentrated to a desired consistency, which is a liquid of about 15 to 20 per cent water. Formerly sulphuric acid was the acid used for conversion; but on account of its carrying arsenic its use was stopped. The solids of commercial glucose consist of about one-third dextrose and two-thirds dextrin. The dextrins present in commercial glucose are of a different character from those present in floral honey or honeydew, and by this property its presence in honey can be easily detected.

By increasing the amount of acid, and also lengthening the time of heating, products are made which contain more dextrose and less dextrin. These are known commercially as "70," "80,", and "anhydrous starch sugar." They are, for the most part, solid. Their use in honey adulteration is very rare, and, if used, their detection is comparatively easy for a trained chemist.

Commercial glucose is often called corn syrup.

The ease with which commercial glucose can be detected when mixed with honey has led to its disuse except in mixtures so labeled. (See Adulteration of Honey.)

Analysis of American commercial glucose according to Bryan, published in the Journal of the Franklin Institute for October, 1911, shows the following average, maximum, and minimum figures:

	Aver.	Max.	Min.
Water	16.47%	20.00%	11.95%
Dextrose	35.51	39.56	30.21
Mineral matter	.52	.91	.24
Undetermined	47.50	52.49	40.46
Direct polarizations:			
At 20° C.	+173.9	+184.3	+155.8
At 87° C.	+166.0	+176.6	+150.0
Invert polarizations:			
At 20° C.	+173.1	+183.2	+155.6
At 87° C.	+163.6	+174.0	+146.4

The undetermined matter, so reported, is composed of dextrose and partially converted starch products.

The percentage of dextrose given is really the percentage of reducing (of Fehling solution) bodies calculated as dextrose. It may contain the sugar maltose and some of the reducible dextrin.

German glucose, according to Herzfeld, published in the above article, shows the following:

	Aver.	Max.	Min.
Water	19.7%	20.4%	18.0%
Dextrose	40.7	47.4	36.5
Mineral matter	.276	.404	.179
Polarization:			
Direct at 20°	+161.6	+181.2	+149.6
Invert at 20°	+154.7	+161.2	+138.4

Starch sugars show the following composition according to Bryan (also given in same paper).

Crystalline sugars (often referred to as anhydrous sugar):

	Aver.	Max.	Min.
Water	7.42%	9.94%	5.04%
Dextrose	86.33	90.70	81.52
Dextrine	.39	.54	.16
Mineral matter	.73	1.06	.48
Undetermined	5.13	7.53	2.77
Polarization:			
100 grams to 100cc			
	+27.89	+28.65	+27.50
Dextrose calculated from polarization-			
	91.59%	94.08%	90.31%

"Climax sugar," or 80 sugar:

	Aver.	Max.	Min.
Water	9.84%	10.61%	9.06%
Dextrose	77.54	77.84	77.24
Dextrin	1.04	1.15	.96
Mineral matter	1.18	1.18	1.17
Undetermined	10.40	10.96	9.83
Polarization:			
10 grams to 100cc—			
	+27.45	+28.40	+26.50
Dextrose calculated from polarization:			
	90.12%	93.20%	87.03%

"Nabob sugar," or 70 sugar:

	Aver.	Max.	Min.
Water	16.43%	18.03%	13.77%
Dextrose	69.81	73.16	66.60
Dextrin	1.17	2.42	.57
Mineral matter	.80	1.12	.45
Undetermined	11.79	14.35	9.30
Polarization:			
10 grams to 100cc—			
	+28.94	+33.45	+24.90
Per cent dextrose calculated from the polarization	95.05	109.85	81.77

In these tables it is noted that the two

percentages of dextrose given do not agree. That one calculated from the polarization is always high on account of the influence of the amount of dextrin (this having a larger polarization influence than dextrose).

GOLDENROD (*Solidago*).—The goldenrods and asters are the most common and conspicuous of autumn flowers in eastern North America. Goldenrod begins to bloom at midsummer, or earlier in the case of the early goldenrod, and in November there are still visible the flower clusters of the Canada goldenrod and the tall hairy goldenrod, while the salt marsh goldenrod may prolong the season until December.

Although the individual heads are so small, conspicuousness is gained by massing them in great plume-like clusters or panicles. Their bright yellow color renders them visible both by day and evening; and as the temperature at night is several degrees above the surrounding air they sometimes serve as a temporary refuge for insects. The floral tube is very short, seldom over one millimeter in length, so that there are few insects which are unable to gather the nectar. The honeybee visits the

Hairy goldenrod.

florets so rapidly that the number of visits per minute can not be counted. A large amount of pollen is gathered both by the domestic bee and by wild bees. So abundant, indeed, are the flowers, and so ample the stores of pollen and nectar that

Three species of goldenrod.

four or five of our native wild bees, which fly only in autumn, never visit any other plants. Some of the goldenrods are pleasantly scented. Others are nearly odorless.

In New England many species of goldenrod grow luxuriantly in pastures and waste lands, and are almost the sole dependance of the beekeeper for winter stores. The bees work on the flowers with great eagerness, and the activity in the apiary equals that of the midsummer honey flow. In Massachusetts a marketable surplus, according to Burton N. Gates, is often taken in September. Allen Latham states that once in three or four years strong colonies in his apiary on Cape Cod will store upward of a hundred pounds from fall flowers. In southern Maine the bees never fail to fill many frames with goldenrod honey, which, because of its golden-yellow color and fine flavor, is preferred by many persons to white honey. In other sections, as the South and West, it is of less importance; but it comes at a time of the year when it helps to keep the bees busy, and at the same time serves to make up the loss in stores during the latter part of the summer.

The species most common and valuable to eastern beekeepers are sweet-scented goldenrod *(S. odora)*, early goldenrod *(S. juncea)*, field goldenrod *(S. nemoralis)*, Canada goldenrod *(S. canadensis)*, late goldenrod *(S. serotina)*, tall hairy goldenrod *(S. rugosa)*, and in great abundance in salt marshes and along sea-beaches, the seaside goldenrod *(S. sempervirens)*. Unlike most of the other species, the inflorescence of the common bushy goldenrod *(S. graminifolia)* is in large flat-topped clusters or corymbs. It is one of the best nectar-yielders, and a favorite with honeybees. Once in a woodland pasture largely overgrown with the hairy goldenrod *(S. rugosa)* a dozen or more plants of the bushy goldenrod were found. Honeybees were the only insects present, and they showed a marked preference for the bushy goldenrod. They were repeatedly seen to leave the latter species; and after flying about, but not resting on the flowers of the hairy goldenrod, return to the plants they had left a few moments before. A plant of each of the above species was bent over so that their blossoms were intermingled, appearing as a single cluster; a honeybee alighted on the bushy goldenrod, and it seemed very probable that it would pass


Sweet goldenrod (Solidago odora.)

over to the flowers of the hairy goldenrod, but such was not the case, for presently it flew away to another plant of the former. The flowers have a sweet fragrance, and are visited by over a hundred different insects. All the goldenrods in New England yield nectar, although the early

goldenrod (*S. juncea*) seems to be of less value than some of the later kinds.

The quantity of nectar secreted by the goldenrods varies greatly in different localities. They are most valuable as honey plants in New England and Canada. In a large part of New England beekeeping is chiefly dependent on this plant and the clovers, and in the absence of either group would yield little profit. The goldenrods are also abundant in Nova Scotia and New Brunswick and in parts of Quebec, Ontario, and Manitoba. They yield nectar freely, and 40 or more pounds of honey per colony from this source may be obtained, but usually it is mixed with aster honey.

Goldenrod is also listed among the honey plants of British Columbia, Michigan, and Tennessee, and is widely distributed in New York, New Jersey, and other eastern states, although not of great importance. It is apparently of more value in Florida, Louisiana, and Texas.

But in the white clover belt, in Iowa, Illinois, and the adjoining states, the goldenrods yield little or no nectar. Great masses of the clustered flowers are visited only occasionally by bees. The conditions which produce the secretion of a great amount of nectar in white clover do not produce the same results in the case of goldenrod. In the arid cactus region of the Southwest and in the semi-arid regions of the Rocky Mountain Highlands these plants are either absent or no help to the beekeeper. Again, in California they are the source of a small amount of honey. In New England the bushy goldenrod *(S. graminifolia)* and the tall hairy goldenrod *(S. rugosa)* yield the most nectar; in Canada, *S. squarrosa* and *S. puberula;* and in California, *S. californica* and *S. occidentalis*.

While the bees are bringing in the nectar, the whole apiary is filled with a disagreeable smell, which on a calm evening can easily be perceived at a distance of 100 feet. The odor observed during a goldenrod honey flow has sometimes been likened to that of decaying carrion.

Goldenrod honey is very thick and heavy, with the golden-yellow color of the blossoms. The quality is poor when first stored, but when capped and thoroughly ripened the flavor is rich and pleasant. It is the general testimony of New England beekeepers that many persons prefer this honey to any other. They regard its color, body, and flavor as the qualities of an ideal honey. When served on a plate for table use it is hardly less attractive than white-clover honey. Its genuineness is never questioned. But the flavor is stronger than that of white clover, which would probably be given the preference by the majority as the great universal staple to be used with bread and butter.

Goldenrod seldom fails to yield freely even in cold and wet weather, but it does exceptionally well during a warm dry fall. The honey has always proven an excellent winter food for bees, and without it there would be little hope for bee culture in New England. So far as the beekeeper is concerned, goldenrod is well named, and it would be a want of gratitude not to uphold its claims as our national flower.

For pictures of other species, see "Honey Plants of North America."

GOVERNMENT AID TO BEEKEEPERS.—There are many offices throughout the government service, particularly in the United States Department of Agriculture that give assistance to beekeepers, but the Bee Culture Laboratory, a division of the Bureau of Entomology and Plant Quarantine, is the only office whose entire time, personnel and funds are devoted exclusively to beekeeping.

Mr. Frank Benton was placed in charge when the laboratory was established nearly thirty years ago. Benton was not, strictly speaking, a scientific man, but an enthusiast. At that time, when commercial beekeeping was struggling for recognition, the enthusiasm of Benton served an excellent purpose, for it was greatly needed, and he deserves a great deal of credit for the inspiration he gave to the industry. His beekeeping manual issued by the government in 1895 had wide circulation, thousands of copies being distributed to the beekeepers of the country.

Upon the resignation of Benton in 1907, Dr. E. F. Phillips, a well trained scientist, was placed in charge of the Bee Culture Laboratory, and since that time scientific research has been the predominating work of the Laboratory, with the exception of the period of the World War, when extension work was substituted for scientific investigations as a temporary exigency to stimulate the production of honey in the face of high prices and shortage of sugar which then prevailed.

Because of limited appropriations the

scope of the work has been confined almost entirely to fundamental research, thus most of the investigations carried on under Phillips' guidance have been of an exceedingly fundamental nature, and only in cases of emergency have problems of strictly local character been undertaken. Such problems as bee diseases, wintering, behavior of bees, swarm control, anatomy, physiology—problems of general importance to all beekeepers in all places—have constituted typical lines of investigation.

Phillips was instrumental in bringing into the Bee Culture Laboratory such eminent investigators as G. F. White, R. E. Snodgrass, Burton N. Gates, D. B. Casteel, James A. Nelson, George S. Demuth, Arthur H. McCray, A. P. Sturtevant, W. J. Nolan, E. L. Sechrist, and others.

White's investigations on the diseases of the brood of bees were relatively pioneer efforts in the field of bee diseases, and his work has had a marked influence upon American beekeeping since many of the present standard practices for preventing and controlling bee diseases are based upon White's early researches.

McCray and Sturtevant have likewise made valuable contributions to our knowledge of bee diseases.

Casteel's work on pollen collecting and manipulation of wax scales by the honeybee are typical of fundamental investigations so badly needed in the broad field of bee behavior.

Nelson's work on embryology and his bulletin on the morphology of the larva of the honeybee are other examples of pure scientific research which may appear unimportant to the layman, but which actually constitute foundation stones in the building of sound beekeeping practices.

The investigations of Gates upon hive temperature, and the subsequent researches of Phillips and Demuth in the same field and their practical significance in the solution of wintering problems, have had tremendous influence upon American beekeeping practices. (See Temperature.)

The careful studies and analyses made by Demuth have resulted in the application of scientific principles to swarm control and commercial honey production, and have been instrumental in promoting commercial honey production throughout the world. Demuth had the ability to put into practical application the results of scientific research.

During recent years Nolan's investigations on brood-rearing and egg-laying have added valuable information to these important subjects, upon which hitherto little careful work has been done. Perhaps of still greater importance, the ultimate value of which is almost impossible to estimate, is Nolan's work on the breeding of the honeybee. The Watson method for artificially mating queens has been improved in the careful hands of Nolan to a point where the number of successfully mated queens is limited only by financial outlay. Although the technique of artificially mating queens has not reached a point where it can be used in the production of commercial queens, it is amply perfected to give plenty of material to conduct scientific investigations in breeding. The ultimate object of the work is, of course, to produce superior strains of bees, and with mating controlled there is no biological reason why strains can not be developed that are particularly adaptable, for example, for the production of comb honey; strains for pollinating purposes, particularly in sections of the country where bad weather prevails in the spring; strains that will withstand our rigorous winters; bees with longer tongues; bees that can fly farther and carry more; gentler bees, etc.—the field is almost unlimited.

The work inaugurated by Sechrist in the field of beekeeping economics has struck a popular appeal in various parts of the country with the result that several state educational institutions are now co-operating with the Bee Culture Laboratory in conducting studies on the cost of producing honey, methods of apiary management, and various phases of honey marketing. The publication of Circular 24, "United States Grade, Color Standards, and Packing Requirements for Honey," has had a stimulating effect, and, although beekeepers generally are still not alive to the advantages of careful grading, a few states have adopted the United States grades and are promoting their use.

Doctor Phillips resigned his position in the government service in 1924 to accept the Professorship of Apiculture at Cornell University, and was succeeded in charge of the Bee Culture Laboratory by Jas. I. Hambleton.

In 1925 the Congress appropriated funds for the establishment of a bee culture field laboratory to be located in the

Intermountain States, resulting in the establishment of the Intermountain States Bee Culture Field Laboratory on the campus of the University of Wyoming, Laramie, Wyoming. Beekeeping problems peculiar to the Intermountain States occupy the attention of the staff, which is in charge of Dr. A. P. Sturtevant, the well-known specialist on diseases of bees. Researches on American foulbrood, studies on the flight range of the honeybee, and the wintering of bees indicate the general character of the work of this laboratory.

In 1928 the Congress indicated its growing belief in beekeeping by appropriating sufficient funds to establish a second field laboratory. Consequently upon the invitation of the beekeepers of Louisiana, the Southern States Bee Culture Field Laboratory was established co-operatively on the campus of the State University of Louisiana, Baton Rouge, La. Dr. Warren Whitcomb, Jr., was placed in charge of this laboratory which was organized to make investigations in the production of package bees, queen-rearing, and southern honey flora.

A third laboratory, known as the Pacific States Bee Culture Field Laboratory, was established in 1931 on the campus of the Northern Branch College of Agriculture, University of California, Davis, California, and placed in charge of Mr. E. L. Sechrist. In co-operation with the Giannini Foundation, and with the Oregon Experiment Station, this laboratory has made pioneer researches in the field of beekeeping economics, a subject that has been badly neglected in this country. Problems that relate particularly to beekeeping on the Pacific Coast concern this laboratory.

All three of the field laboratories are advantageously located. Each is close to good beekeeping localities where contact can be maintained with beekeepers, and where the facilities of the laboratories are in turn available to the beekeepers. The co-operative arrangements which have been made with the state universities have brought to the field laboratories facilities in the way of scientific stimulation and physical equipment that have proved invaluable. This arrangement has also helped to make available to the beekeepers certain facilities of the universities.

In addition to purely investigational problems, the work of the Bee Culture Laboratory has of necessity covered a wide field. The reason for this is quite evident when one considers the close relationship between beekeeping and botany, zoology, physiology, geology, meteorology, physics, chemistry, soils, and other allied sciences.

The Bee Culture Laboratory of the Department and its field or branch laboratories have assumed a great variety of diverse duties. They often act in an advisory capacity in matters pertaining to bee disease legislation. Hundreds of samples of bee diseases from all parts of the United States and from foreign countries are diagnosed annually. All adult bees imported into the United States must pass through the Washington office of the Bee Culture Laboratory and be examined for the presence of *Acarapis woodi*, a tiny parasitic mite, before the queen can be forwarded to the consignee. This is the only regulatory function of the Bee Culture Laboratory and a wise one in that the United States is one of the few countries in which this disease is not found. Countless questions pertaining to honey, swarming, bee diseases, wintering, queen-rearing, grading, and others, numbering into the thousands, are received and answered every year.

Shortly after the passage of the agricultural adjustment act, May 12, 1933, the producers of package bees and queens in the Southern States and in California requested the assistance of the Bee Culture Laboratory in drawing up a marketing agreement. The combined effort of all parties culminated in the signing by the Secretary of Agriculture on May 2, 1934, of a comprehensive document that placed in the hands of a committee chosen by queen breeders and package producers authority to regulate the package bee and queen industry in such a manner as to serve the best interests of both shippers and buyers of package bees and queens. The prices of package bees and queens had declined to such a low point during the years of the depression that had the shippers of package bees and queens been unsuccessful in their efforts to adopt a marketing agreement, to be supervised by the Agricultural Adjustment Administration, in all probability the package bee business would have passed out of existence at the end of the 1934 shipping season. Although the marketing agreement was not made effective by the Secretary of Agriculture until May 6, 1934, a date well along in

the shipping season, the great majority of the shippers and queen-breeders had agreed among themselves to adopt certain shipping practices and to maintain minimum prices. The 1934 bee shipping season therefore proved to be the largest on record. The adoption of the marketing agreement stands as a noteworthy example of the benefits of co-operative effort.

The marketing agreement provides for the establishment of a Control Committee having supervisory powers. The membership of this committee for the shipping season 1934 is composed of W. E. Harrell, chairman, representative of Alabama; J. E. Wing, representative of California; J. W. Newton, representative of Louisiana; T. W. Burleson, representative of Texas; and D. D. Stover, Mississippi, representative at large. Prof. J. M. Robinson, Alabama Polytechnic Institute, Auburn, Ala., is secretary-treasurer, and Laurence H. Sample, Food Products Section, Agricultural Adjustment Administration, handles the negotiations from the standpoint of the government.

Since 1917, H. J. Clay, Associate Marketing Specialist, Division of Fruits and Vegetables, Bureau of Agricultural Economics, has prepared market news reports on honey. At first these reports covered only a few of the leading consuming centers, but during recent years the producing areas of the country have been included as well as the consuming markets. In nine markets, Boston, Chicago, Denver, Kansas City, Minneapolis, New York, Philadelphia, San Francisco, and St. Louis, representatives of the Division of Fruits and Vegetables obtain twice a month from the leading dealers and receivers of honey the prices at which bottlers and dealers can buy extracted honey, and the prices obtainable for comb honey when sold by large receivers to jobbers or retail grocers.

In addition to the information about prices and markets several pages in the semi-monthly honey reports are devoted to news from the producing areas. To obtain this information report blanks are sent twice a month to about five hundred commercial beekeepers, honey shippers and beekeepers' organizations. Their replies give a fairly representative idea of local conditions, such as the manner in which bees have wintered, the amount of early brood-rearing, crop prospects, etc. In most instances the prices include only the sales of the reporters themselves, and obviously cover but a small proportion of the sales of the country. These reports are also supplemented by prices which have been paid f. o. b. shipping point, obtained from a few brokers or wholesalers. The regular reporters are largely better-informed beekeepers who might be expected to secure a premium for their honey.

Beekeepers who desire to receive regularly the semi-monthly Honey News Reports may write to the Division of Fruits and Vegetables, Bureau of Agricultural Economics, Washington, D. C., or to the Division of Bee Culture Investigations, Washington, D. C., and request that their names be placed on the mailing list.

In co-operation with the Bee Culture Laboratory, the Division of Fruits and Vegetables, Bureau of Agricultural Economics, has developed grades for extracted, comb and bulk comb honey. The United States standard grades for honey were recommended by the government for the sole purpose of facilitating the sale of honey, and their general adoption should materially improve both our foreign and domestic market.

The Division of Crop and Livestock, Bureau of Agricultural Economics, issued between 1914 and 1926, a series of reports covering in a general way the following subjects: Seasonal condition and strength of colonies, number of colonies; seasonal condition of honey plants; prospective and realized yields of honey per colony; mortality of colonies from various causes, including winter losses and losses from various diseases and from insect pests; proportion of the crop extracted, comb, and bulk comb honey; percentage of crop light amber and dark honey; percentage of crop sold locally or to outside markets; prices received by producers; and miscellaneous special studies such as usual blooming dates of various honey plants, percentage of crop derived from different sources in the different states, percentage of swarming by months, etc.

The constantly increasing pressure upon this division for more complete and more accurate information concerning crops and livestock, and the lack of any definite provision of funds for the maintenance of the honey and honeybee reports finally compelled a discontinuance of these. Another reason for discontinuing these reports was undoubtedly the fact that beekeepers did not seem to realize their im-

portance and did not give sufficient co-operation to make them worth while.

It would be difficult to estimate the value of the assistance given to beekeepers by the Bureau of Chemistry and Soils and by the Food and Drug Administration. Under the able leadership of Dr. H. W. Wiley, the first chief of the Bureau of Chemistry (since changed to the Bureau of Chemistry and Soils), the pure food law was enacted. The passage of this law marked one of the most important milestones in the development of the beekeeping industry, for previous to that time adulteration of food products was so common that it was almost impossible to buy pure honey. Since the pure food law has been in effect this country has enjoyed a freedom from artificial and manufactured honeys. These imitation honeys unfortunately are still being sold in a number of foreign countries. Government officials have been vigilant in keeping adulterated honeys out of interstate commerce, so today it is practically impossible to buy any product sold under the name of honey which is not the genuine product. Many chemical studies of American honeys have been made by chemists of the Department of Agriculture and hundreds of samples from various floral sources have been analyzed. Large numbers of arsenical determinations have also been made of bees suspected of being killed by poisonous sprays and dusts.

The Bureau of Agricultural Economics and several of the state universities and agricultural experiment stations in co-operation with the Bee Culture Laboratory are at present making a study of the cost of honey production, systems of management, etc. This is a preliminary step to future investigations in the broad field of honey marketing, upon which much must be done before our marketing problems can be solved.

The Bureau of Home Economics, after many tests and experiments on the uses of honey in cookery, issued a bulletin entitled "Honey and Its Uses in the Home," which has gone into thousands of households. This bureau, with the co-operation of the Bee Culture Laboratory, has also investigated the vitamin content of various honeys, and is at present engaged in the preparation of a bulletin which will give the fundamentals of using honey in cookery.

The Press Service of the United States Department of Agriculture, with the assistance of various government experts, prepares from time to time press releases on a wide variety of agricultural subjects, which include topics relating to the care of bees, uses of honey, etc. These releases are sent to more than a thousand newspapers and magazines in the United States, and thus timely information concerning bees and honey is given wide distribution. Preliminary announcements of new discoveries or new government activities on bees likewise are sent out by the Press Service.

The Office of Motion Pictures, United States Department of Agriculture, has made several motion pictures of bees, the most recent being entitled "The Realm of the Honeybee." This is a four-reel picture available in both 16 and 35 millimeter sizes. This picture does not deal primarily with the commercial production of honey but emphasizes interesting biological facts about bees such as the organization of the colony, nectar and pollen gathering, development of the brood, swarming, how bees communicate, how they defend their hives, and ends with an attractive setting showing uses of honey. The film can be borrowed without cost other than the payment of transportation charges to and from Washington. Although the Department has 19 copies of this film, the demand for it is so great that it is usually necessary for prospective users to reserve the film a month or so in advance. It is the type of film that has been shown with equal satisfaction to all kinds of audiences all the way from those of primary school age to learned scientific societies. The school authorities in a number of cities have been instrumental in showing the picture to the pupils in the public schools.

From time to time the Office of Exhibits, United States Department of Agriculture, has prepared special honey and beekeeping exhibits which are sent to state and county fairs. At present there is available an attractive exhibit showing the chemical components of honey. This exhibit has been shown at a number of important meetings such as the annual convention of the American Home Economic Association and the annual meeting of the American Medical Association. It may be borrowed from the Office of Exhibits, United States Department of Agriculture, Washington, D. C., upon the payment of a deposit of $2.50, plus the trans-

portation charges to and from Washington.

The Bureau of Foreign and Domestic Commerce, United States Department of Commerce, is promoting our export trade in honey. It receives reports from commissioners of trade, commercial attachés and consuls located in the principal honey markets of Europe and other foreign countries, thus keeping our honey trade informed of conditions in foreign markets. These reports are often supplemented by pertinent items giving statistics and other general information about beekeeping conditions abroad. Foreign representatives of the Bureau are constantly looking for new markets for honey and reporting opportunities for making sales.

It is perhaps needless to remark that whatever the government has accomplished along beekeeping lines could not have been done without the splendid co-operation of beekeepers, beekeeping organizations, and the bee press. It is also true that whatever progress is made henceforth by the government will depend to a large extent upon the activity of the beekeepers themselves.

A better knowledge of the valuable amount of work the government has done for the beekeepers of this country may be gained by glancing over the list of the most important publications which have been issued. The number of copies of major publications published by the government figures to a grand total of approximately 6,000,000. This does not take into consideration the thousands of special reports, mimeographed circulars and papers prepared for publication in bee journals and other outside sources. Most of the publications issued by the government have until recent time been available for free distribution. A number of publications, however, particularly the more technical ones are sold at cost and to obtain copies of these postal money orders or cash should be sent to the Superintendent of Documents, Government Printing Office, Washington, D. C. Notice is also given to all the bee journals whenever the government issues a new publication of interest to beekeepers.

The following is a chronological list of the principal government publications pertaining to beekeeping. The majority of the publications listed are out of print and are now available only in libraries and in private collections. Those marked with an asterisk are no longer obtainable except through dealers in second-hand books, but may be consulted in the larger public libraries:

*Foods and food adulterants. Part Sixth. Sugar, molasses, and sirup, confections, honey, and beeswax, by H. W. Wiley. Division of Chemistry, Bulletin 13, p. 633-874. 1892. This bulletin gives the extent and scope of the adulteration of honey, and a complete study of the methods of analyses for beeswax and the indication of adulteration. Contains bibliographies of beeswax arranged by years from 1848 to 1891; also of waxes used in adulterating beeswax from 1863 to 1890; and of honey from 1867 to 1891.

*The honeybee: A manual of instruction in apiculture, by Frank Benton, Entomology Bulletin No. 1, new series. 118 p. 1895. Revised in 1896, and third edition issued in 1899. General beekeeping guide giving instructions in handling bees for the beginner, as well as more advanced information for the commercial beekeeper.

*Beekeeping, by Frank Benton. Farmers' Bulletin 59, 47 p. 1905. Superseded by Farmers' Bulletins 397 and 447.

*The rearing of queen-bees, by E. F. Phillips. Entomology Bulletin 55, 32 p. 1905. Some of the best methods of queen-rearing are given in detail.

*The laws in force against injurious insects and foulbrood in the United States, by L. O Howard and A. F. Burgess. Entomology Bulletin 61, 222 p. 1906. Contains state and territorial laws relative to foulbrood, the full text of the laws of twelve states being listed.

*The brood diseases of bees, by E. F. Phillips. Entomology Circular 79. 5 p. 1906. A nontechnical description of American and European foulbrood, pickled, chilled, overheated, and starved brood, with suggestions for treatment.

*The bacteria of the apiary, with special reference to bee diseases, by Gershom Franklin White. Entomology Technical Series 14, 50 p. 1906. A technical bulletin in two parts. Part I deals with bacteria found in a normal apiary, and Part II deals with the bacteria which cause diseases of bees.

*Report of the meeting of Inspectors of Apiaries, San Antonio, Tex., November 12, 1906. Entomology Bulletin 70, 79 p. 1907. Contains papers on the bacteriology of bee diseases, and the status of their investigation, treatment, geographical distribution, etc.

*The cause of American foulbrood, by G. F. White, Entomology Circular 94, 4 p. 1907. An account stating the cause of American foulbrood and definitely naming the causative organism Bacillus larvae, with announcement of a satisfactory medium for culturing this organism.

*Chemical analysis and composition of American honeys, including a microscopical study of honey pollen, by C. A. Browne and W. J. Young. Chemistry Bulletin 110, 93 p. 1908. This is an account of the first comprehensive and systematic study made on honey produced in the United States, contains the chemical analyses of over one hundred different kinds of honey. Several chapters are devoted to a microscopical study of honey pollen with a brief key to pollens most commonly found in American honeys. Contains a list of chemical literature on honey from 1892 to 1907.

*Hawaiian honeys, by D. L. Van Dine and Alice R. Thompson. Hawaii Agricultural Experiment Station Bulletin 17, 21 p. 1908. Gives sources, characteristics, and chemical composition of Hawaiian honeys.

*The anatomy of the honeybee, by R. E. Snodgrass. Entomology Technical Series 18, 162 p. 1910. A technical bulletin on the anatomy of the honeybee well illustrated with numerous line drawings. "Anatomy and Physiology of

the Honeybee,'' published in 1925 by McGraw-Hill Book Co., Inc., New York, is an outgrowth of Technical Series 18 revised and enlarged. This is now published in book form and is no longer obtainable as a government publication.

*Bees, by E. F. Phillips. Farmers' Bulletin 397, 44 p. 1910. Supersedes Farmers' Bulletin 59, and later replaced by Farmer's Bulletin 447.

*Miscellaneous papers on apiculture. I. Production and care of extracted honey, by E. F. Phillips: Methods of honey testing for beekeepers, by C. A. Browne. II. Wax moths and American foulbrood, by E. F. Phillips. III. Bee diseases in Massachusetts, by Burton N. Gates. IV. The relation of etiology (cause) of bee diseases to the treatment, by G. F. White. V. A brief survey of Hawaiian beekeeping, by E. F. Phillips. VI. The status of apiculture in the United States, by E. F. Phillips. VII. Beekeeping in Massachusetts, by Burton N. Gates, Entomology Bulletin 75, 123 p. 1911. These papers were also issued separately during the years 1907, 1908, and 1909.

*The occurrence of bee diseases in the United States, by E. F. Phillips, Entomology Circular 138, 25 p. 1911. Report giving the name of all countries in which European foulbrood and American foulbrood had been reported. The status of the apiary laws of various states is mentioned.

*Bees, by E. F. Phillips. Farmers' Bulletin 447, 48 p. 1911. Supersedes Farmers' Bulletins 59 and 397. These three bulletins contain a practical text on beekeeping, dealing with such subjects as the location of the apiary, equipment, general manipulations, swarm-control, and other information useful particularly to the beginner.

*The refractive index of beeswax, by L. Feldstein. Chemistry Circular 86, 3 p. 1911. The refractive index of samples of pure waxes and of so-called commercial and adulterated waxes are given.

*Historical notes on the causes of bee diseases, by E. F. Phillips and G. F. White. Entomology Bulletin 98, 96 p. 1912. A review of some twenty authors' writings on bee diseases.

*Chemical analysis and composition of imported honey from Cuba, Mexico, and Haiti, by A. Hugh Bryan, with the co-operation of Arthur Given and Sidney Sherwood. Chemistry Bulletin 154, 21 p. 1912. The contents of this bulletin are well indicated by the title, and it also contains a list of chemical literature on honey from 1907 to 1911.

*The cause of European foulbrood, by G. F. White. Entomology Circular 157, 15 p. 1912. A technical discussion of the cause of European foulbrood. This is the first account of the naming of the causative organism of European foulbrood, Bacillus pluton.

*The manipulation of the wax scales of the honeybee, by D. B. Casteel. Entomology Circular 161, 13 p. 1912. An account of observations on bees in manipulating wax scales.

*The behavior of the honeybee in pollen collecting, by D. B. Casteel. Entomology Bulletin 121, 36 p. 1912. A detailed study of the behavior of the individual bee in collecting pollen, describing the action of the three pairs of legs and mouth parts. Includes also general statements on the pollen-collecting process, such as moistening and storing pollen in the hive.

*Comb honey, by Geo. S. Demuth. Farmers' Bulletin 503, 47 p. 1912. Superseded by Farmers' Bulletin 1039.

*Sacbrood, a disease of bees, by G. F. White. Entomology Circular 169, 5 p. 1913. A preliminary report on sacbrood, describing the symptoms and the infectious nature of this disease.

The temperature of the honeybee cluster in winter, by E. F. Phillips and George S. Demuth. Department Bulletin 93, 16 p. 1914. By the use of electrical thermometers a detailed study of the temperatures in various parts of the hive were carried on during the wintering period. The effect of the external temperature on the heat production of the honeybee is noted, as well as the effect of confinement and the accumulation of feces on heat production. Methods of heat production and conservation in the bee are described.

*Destruction of germs of infectious bee diseases by heating, by G. F. White. Department Bulletin 92, 8 p. 1914. The time and the degree of heat necessary to destroy germs of European foulbrood, sacbrood, American foulbrood, and Nosema disease are given.

*Porto Rican beekeeping, by E. F. Phillips, Porto Rico Agricultural Experiment Station Bulletin 15, 24 p. 1914. General survey of beekeeping in Porto Rico with a list of the principal nectar-secreting plants.

*The Temperature of the bee colony, by Burton N. Gates. Department Bulletin 96, 29 p. 1914. Temperature records made on colonies of bees throughout the wintering period showing the relation of the temperature in various parts of the hive and cluster to the outside temperature.

*Honey and its uses in the home, by Caroline L. Hunt and Helen W. Atwater. Farmers' Bulletin 653, 22 p. 1915. The value of honey is considered primarily from its energy producing qualities. Many tested recipes for the use of honey are given along with a discussion of honey in cookery.

*Outdoor wintering of bees, by E. F. Phillips and George S. Demuth. Farmers' Bulletin 695, 12 p. 1915. Superseded by Farmers' Bulletin 1012. The fundamental principles for the successful outdoor wintering of bees.

*Honeybees: Wintering, yields, imports, and exports of honey, by Samuel A. Jones. Department Bulletin 325, 12 p. 1915. Gives data on wintering of honeybees 1914-15, and figures covering exports and imports of honey from 1910 through 1914.

*The treatment of bee diseases, by E. F. Phillips. Farmers' Bulletin 442, 20 p. 1916. Revised in 1916. Farmers' Bulletins 975 and 1084 replaced this bulletin. Gives the symptoms and outlines treatment for American and European foulbrood. Dysentery, so-called paralysis, and Isle of Wight disease are briefly considered.

*A survey of beekeeping in North Carolina, by E. G. Carr. Department Bulletin 489, 16 p 1916. The contents of this bulletin are indicated by the title.

*Sacbrood, by G. F. White, Department Bulletin 431, 54 p. 1917. A well illustrated technical bulletin describing the symptoms of this disease, which is set forth as being caused by a filterable virus. Details of experimental work dealing with the transmission of the disease and the effect of various disinfectants, including sunlight, upon resistance of the virus are fully described.

*Spore-forming bacteria of the apiary, by Arthur H. McCray. Reprint K-51, Jour. Agr Research, vol. VIII, No. 11, 1917. Description and composition of Bacillus vulgatus, B. mesentericus, B. orpheus, B. alvei, and B. larvae, spore-forming bacteria commonly found in the apiary.

*The diagnosis of bee diseases by laboratory methods, by Arthur H. McCray and G. F. White. Department Bulletin 671, 15 p 1918 Gross characters and microscopic findings encountered in making laboratory diagnoses. The common bee diseases are described.

*Honeybees and honey production in the United States, by S. A. Jones. Department Bulletin 685, 61 p. 1918. A rather comprehensive survey of the beekeeping industry in the United States, giving information on the number of colonies of bees, increase of swarming, wintering losses, yields of honey per colony, and other statistical data. Space is also devoted to a discussion of the sources of pollen and nectar, supply and prices, and value of exports and imports from 1911 to 1917.

Transferring bees to modern hives, by E. L.

Sechrist. Farmers' Bulletin 961, 15 p. 1918. Various methods are described for transferring bees from hollow logs and box hives into modern movable-frame hives. Revised by James I. Hambleton, November, 1932.

The control of European foulbrood, by E. F. Phillips. Farmers' Bulletin 975, 16 p. 1918. Symptoms, preventive and remedial measures are discussed.

The preparation of bees for outdoor wintering, by E. F. Phillips and George S. Demuth. Farmers' Bulletin 1012, 20 p. 1918. Practical instructions for preparing and packing colonies of bees for outdoor wintering, with specifications for constructing quadruple packing-cases.

Wintering bees in cellars, by E. F. Phillips and George S. Demuth. Farmers' Bulletin 1014, 21 p. 1918. Construction and care of ideal cellars for wintering bees, with instructions for putting bees into the cellar and taking them out.

*Nosema disease, by G. F. White. Department Bulletin 780, 59 p. 1919. Technical bulletin giving the symptoms of this disease and the results of laboratory studies dealing with infectiousness and modes of transmission, effect on the colony, resistance of the spores of Nosema apis to heating, drying, carbolic acid, etc., etc.

Commercial comb-honey production, by Geo. S. Demuth. Farmers' Bulletin 1039, 40 p. 1919. Supersedes Farmers' Bulletin 503. The equipment necessary for the production of comb honey, the manipulation of bees, swarm prevention control, the manipulation of supers, and preparing honey for market are among the subjects treated in full detail. Slightly revised October, 1932.

*American foulbrood, by G. F. White. Department Bulletin 809, 46 p. 1920. Technical description giving symptoms and etiology of American foulbrood, with data on resistance of spores to various disinfectants, sunlight, etc.

*European foulbrood, by G. F. White. Department Bulletin 810, 39 p., 1920. Technical description, giving symptoms and etiology of European foulbrood, with data on resistance of spores to various disinfectants, sunlight, etc.

*Control of American foulbrood, by E. F. Phillips, Farmers' Bulletin 1084, 15 p. 1920. Practical instructions for identifying and treating this disease.

*A study of the behavior of bees in colonies affected by European foulbrood, by Arnold P. Sturtevant. Department Bulletin 804, 28 p. 1920. An account of observations made on the behavior of bees in colonies infected with this disease, giving the incubation period of the organism, relation of strength of colony to ability to overcome the disease, and a study of the superiority of Italians over hybrids, etc.

Swarm control, by Geo. S. Demuth. Farmers' Bulletin 1198, 47 p. 1921. Detailed consideration is given to factors influencing the tendency to swarm, such as heredity, the hive and combs, size of brood-chamber, space within the hive, ventilation, shade, locality, season, young bees, etc. Directions are given for hiving swarms, prevention of swarming, manipulation of colonies and supers during the swarming season.

*Heat production of honeybees in winter, by R. D. Milner and Geo. S. Demuth. Department Bulletin 988, 18 p. 1921. A technical discussion of the amount of energy produced by bees under wintering conditions.

Beekeeping in the clover region, by E. F. Phillips and George S. Demuth. Farmers' Bulletin 1215, 22 p. 1922. A worked-out plan of apiary management for obtaining best results in the clover region. Revised October, 1932.

Beekeeping in the buckwheat region, by E. F. Phillips and George S. Demuth. Farmers' Bulletin 1216, 26 p. 1922. A worked-out plan of apiary management for obtaining best results in the buckwheat region.

Beekeeping in the tulip-tree region, by E. F. Phillips and George S. Demuth. Farmers' Bulletin 1222, 25 p. 1922. A worked-out plan of apiary management for obtaining best results in the tulip-tree region.

*The occurrence of diseases of adult bees, by E. F. Phillips. Department Circular 218, 16 p. 1922. Contains a description of Isle of Wight disease and a short historical sketch of its discovery, also tables giving the distribution of Nosema apis in this country by months, years and states.

*The insulating value of commercial double-walled beehives, by E. F. Phillips. Department Circular 222, 10 p. 1922. This contains a series of temperature tests on commercial insulated hives, with a discussion of the relative efficiency of various packing materials and methods of packing.

The occurrence of disease of adult bees, II, by E. F. Phillips, Department Circular 287, 34 p. 1923. The distribution of Isle of Wight disease throughout the world, and a copy of the act to regulate foreign commerce in the importation into the United States of adult honeybee (Apis mellifica), with sepcial rules and regulations, is contained in this circular.

*Growth and feeding of honeybee larvae, by James A. Nelson, Arnold P. Sturtevant, and Bruce Lineburg. Department Bulletin 1222, 38 p. 1924. Part I is devoted to the rate of growth of the honeybee larvae and Part II to the feeding of the honeybee larvae, in which are recorded the number of visits made by the nurse bees per day to growing larvae. Methods of feeding and kinds of food are given.

*The development of American foulbrood in relation to the metabolism of its causative organism, by A. P. Sturtevant. Reprint K-128, Jour. Agric. Research, vol. XXVIII, No. 2, 1924. A technical study of the factors which inhibit and favor the growth of Bacillus larvae in honeybee larvae.

*Morphology of the honeybee larva, by James A. Nelson. Reprint K-141, Jour. Agric. Research, vol. XVIII, No. 12, 1924. A technical description of the internal and external anatomy of full-grown honeybee larva.

*The bee-louse, Braula coeca, in the United States, by E. F. Phillips. Department Circular 334, 12 p 1925. Description, habits, and geographical distribution of this rather rare pest of bees.

*The flight activities of the honeybee, by A E. Lundie. Department Bulletin 1328, 38 p 1925. Technical analysis of data on flight activity of the honeybee obtained by means of electrical recording apparatus.

The effect of weather upon the change in weight of a colony of bees during the honey flow, by James I. Hambleton. Department Bulletin 1339, 52 p. 1925. An analysis by statistical methods of the effect of various weather factors upon changes in weight of a colony of bees during the spring and fall honey flows.

The brood-rearing cycle of the honeybee, by W. J. Nolan. Department Bulletin 1349, 56 p., 1925. A detailed study of colonies of bees during the brood-rearing season in which exact counts were made in each colony of all emerged brood. The amount of egg-laying, migration of the queen within the hive, time relation of brood reared to nectar gathered, season brood-rearing characteristics, and many other important subjects dealing with brood-rearing are presented.

*The color grading of honey, by E. L. Sechrist. Department Circular 364, 8 p. 1925. Superseded by Circular 24. Contains a description of the honey grader invented by Dr. A. H. Pfund, of Johns Hopkins University, and adopted by the government as the official grader for the color-grading of honey in accordance with United States standard grades for honey.

The Sterilization of American foulbrood combs, by A. P. Sturtevant. Department Circular 284, 29 p. 1926. A technical account of experimental results obtained by sterilizing American foulbrood combs with Hutselman's solu-

tion, water-formalin solution, and other disinfectants.

Effects on honeybees of spraying fruit trees with arsenicals, by N. E. McIndoo and G. S. Demuth. Department Bulletin 1364, 32 p., 1926. An account of laboratory and field experiments of the effects on honeybees of spraying fruit trees with various arsenicals.

*United States standards for honey, by E. L. Sechrist, H. W. Samson, and others. Department Circular 410, 32 p. 1927. Superseded by Circular 24. A description of all standard grades for honey, including extracted, comb, and bulk comb honey recommended by the United States Department of Agriculture.

The utilization of carbohydrates by honeybees, by E. F. Phillips. Reprint N. Y. (Cornell) 11. Jour. Agric. Research, vol. XXXV, No. 5. 1927. A series of cage tests conducted to ascertain the ability of adult honeybees to utilize various sugars.

*The utilization of carbohydrates as food by honeybee larvae, by L. M. Bertholf. Reprint K-194, Jour. Agric. Research, vol. XXXV, No. 5, 1927. Methods were devised for artificially feeding honeybee larvae on various sugars to determine those which the larvae could utilize.

United States grades, color standards, and packing requirements for honey, by E. L. Sechrist, H. W. Samson, and others. Circular 24, 32 p. 1927. This circular replaces Circulars 364 and 410, and contains full definitions of all grades of honey, with directions for grading, marking, and packing. This bulletin is accompanied by a condensed grading chart and a color chart giving the color requirements of comb honey used to supplement the definitions. This latter is sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 cents.

"It's All Good Honey," 1927. A large attractive five-color educational poster containing pertinent information on honey. This is for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 cents.

Preliminary Report on Apiary Organization and Honey Production in the Intermountain States in 1928, by E. L. Sechrist and R. S. Kifer. Bureau of Entomology, Mimeographed Circular. 18 p. 1929. The first of a series of reports concerning economic studies of beekeeping conducted co-operatively by the Bureau of Entomology and the Bureau of Agricultural Economics, giving figures on items of expense in commercial apiaries of various sizes and details relative to the amount and distribution of labor in honey production.

Vitamin content of honey and honeycomb, by Hilda Black Kifer and Hazel E. Munsell. Reprint T-2, Jour. Agric. Research, vol. XXXIX, no. 5, 1929.

List of publications on apiculture contained in the U. S. Department of Agriculture Library and in part those contained in the Library of Congress, compiled by Vajen E. Hitz and Ina L. Hawes. U. S. Department of Agriculture Library, Bibliographical Contributions no. 21. 1930. 218 p.

Fungous Diseases of the Honeybee, by C. E. Burnside. Technical Bulletin 149, 42 p. 1930. An account of investigations dealing with various species of fungi known to attack bees.

Reactions of the Honeybee to Light, by Lloyd M. Bertholf. Reprint K-215. Jour. Agric. Research, vol. XLII, no. 7, 1931. (See Bee Behavior.) A technical account of experiments showing the response of honeybees to various wave lengths in the visible spectrum.

The Distribution of Stimulative Efficiency in the Ultra-Violet Spectrum for the Honeybee, by Lloyd M. Bertholf. Reprint K-223, Jour. Agric. Research, vol. XLIII, no. 8, 1931. A technical paper which is more or less a continuation of the preceding paper but dealing with the response of honeybees in the ultra-violet spectrum.

Recommendations for shipping cages for bees, by Warren Whitcomb, Jr. Bureau of Entomology. Mimeographed circular E-287. 10 p. 1931.

The development of package bee colonies, by W. J. Nolan. Technical bulletin 309, 44 p. 1932. A detailed study of the development of package bees giving the time required to build up full strength colonies and such practices as the relationship between size of package and the rapidity of building up. It also contains information regarding the installation and care of packages, etc.

Relation of commercial honey to the spread of American foulbrood, by A. P. Sturtevant. Reprint K-228, Jour. Agric. Research, vol. XLV, no. 5, 1932. Healthy colonies were inoculated with known numbers of spores of American foulbrood and the minimum number that was required to inoculate a colony was determined. The effect of the number of spores in culture upon the variation in time of germination was also determined. This paper also gives an account of the spore content of approximately 200 samples of commercial honey.

*Breeding the honeybee under controlled conditions, by W. J. Nolan. Technical bulletin 326, 49 p. 1932. Detailed account of methods and of results obtained of mating queens through the use of instruments. This is a technical discussion and outlines methods that are satisfactory for scientific purposes but not for the commercial production of artificially mated queens. (Please note the asterisk before this publication, denoting that it is no longer available for distribution.)

Cost of producing honey in Oregon, by A. S. Burrier, Frank E. Todd and H. A. Scullen. Circular of Information 83, Agricultural Experiment Station, Corvallis, Oregon. 13 p. 1932. A report of one year's survey giving the operating costs including time, labor, and money of 93 Oregon beekeepers operating close to 18,000 colonies.

Honey Marketing in California, by Edwin C. Voorhies, Frank E. Todd, and J. K. Galbraith. Bulletin 554, Agricultural Experiment Station, Berkeley, Calif, 31 p. 1933. A study of marketing channels for honey and a survey of marketing practices in California including number of trade brands, size and shape of containers, quality, price and price cutting, and suggestions for improving the marketing of honey.

United States grades, color standards, and packing requirements for honey, by G. E. Marvin and R. L. Spangler. Circular 24 (revised), 28 p. 1933. A full description of the various grades and colors of honey and packing requirements recommended by the United States Department of Agriculture. Accompanying this circular is a chart showing at a glance the specifications of the various grades of honey and a second chart illustrating the different color classes for comb honey. (See Honey Grading.)

Diagnosis of bee diseases in the apiary, by C. E. Burnside. Lecture notes for lantern slide series 171. 9 p. 1933. This is a mimeographed circular giving an explanation of all illustrations appearing in Lantern Slide Series 171.

The flight range of the honeybee, by John E Eckert. Reprint K-242. Jour. Agric. Research, vol. XLVII, no. 5. 1933 .(See Flight of Bees.) This is an account of experiments performed in the badlands of Wyoming to determine how far bees will fly to obtain nectar and pollen. It also contains a discussion, based upon data, of the most economical distance to place colonies with respect to sources of nectar.

Economic aspects of the bee industry, by Edwin C. Voorhies, Frank E. Todd, and J. K. Galbraith. Bulletin 555, Agricultural Experiment Station, Berkeley, Calif. 117 p. 1933. A comprehensive treatise giving a great mass of information and figures about the production and distribution of the California honey crop, package bees, queens, and beeswax. It also covers such topics as sources of honey in the United States, exports, imports, etc. (See Statistics Concerning the Bee and Honey Business.)

Some physiological effects of ultra-violet radiation on honeybees, by Lloyd M. Bertholf. Reprint K-243, Jour. Agric. Research, vol XLVII, no. 6, 1933. A paper detailing the results of treating adult bees, brood, and queens with ultra-violet from a quartz mercury vapor lamp.

The treatment of American foulbrood, by Jas. I. Hambleton. Farmers' bulletin 1713. 13 p. 1933. This paper includes a brief description of American foulbrood, European foulbrood, and sacbrood, and gives methods for the control and eradication of American foulbrood.

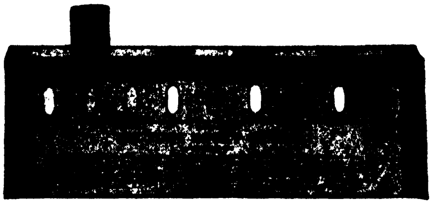
Marketing agreement and license for shippers of package bees and queens produced in the United States. Agricultural Adjustment Administration, Marketing Agreement Series—Agreement no. 43, License Series—License no. 54. 16 p. 1934. A publication of the Agricultural Adjustment Administration giving in full the provisions of the above mentioned marketing agreement known as number 43. It also includes the license in full, known as license number 54. This publication likewise contains the names of all shippers of package bees and queens who, as contracting parties, have signed the agreement.

GRADING HONEY.—Comb and extracted honey, like all other food products, vary in quality and price. The color of extracted may be almost water-white, white light amber, dark amber, or dark. The cappings in comb honey may be pearl-white, yellow, dirty yellow, water-soaked or dark. Usually, the whiter the honey the more delicate and mild the flavor; and conversely, the darker the honey the more pronounced and the stronger the flavor, although there are exceptions to the rule. Some honeys are very thick, running about 12½ pounds to the gallon, while others are thin or unripened, or about 11½ pounds. The average of good or normal honeys is about 12 pounds to the gallon.

When a price is named on a certain lot of honey by mail it is highly important to know the source, color, body or density, and the flavor. Unless there is some standard means of making accurate comparisons or descriptions, or a sample is submitted on which a price is quoted, both the seller and the buyer are at a great disadvantage. But even a sample may be misleading if it comes out of the choicest of the lot and not out of the average or even the poorest. Some severe controversies have arisen between producer and buyer, finally ending in an expensive lawsuit. All such cases can be avoided if some accurate means can be had of describing the whole shipment, along with sample submitted.

But the grading rules or descriptions must be standard and universal in their application. This is just as important as to have a standard yardstick, a standard gallon, or a standard ton, known and accepted by all parties.

Various attempts have been made to establish a set of grading rules for both comb and extracted honey that would be universal in their application. The older editions of this work have contained two different sets of rules—one for the use of eastern beekeepers and the other for the western producers. The differences in localities and the kinds of honey made it impossible for either to be adopted as standard for the whole country. Then attempts were made to compromise by making concessions. While some progress was made for comb honey, there was no way of accurately describing the color of the various extracted honeys. This can be illustrated by saying that what was one man's light amber would be another's amber, especially if he were the buyer. Again, one might classify a honey as "white," while another would call it a light amber, and so on.



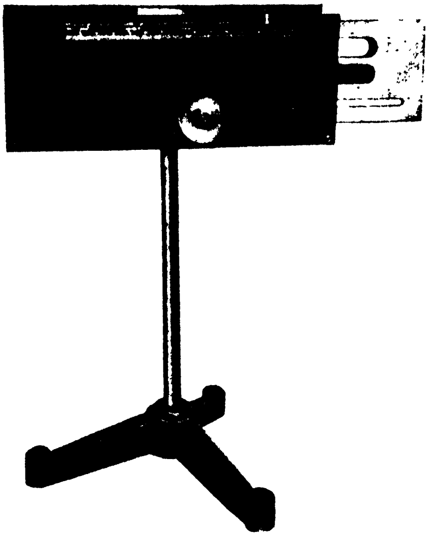
The Root honey-grader.

With this in mind one of the consulting editors of this work, H. H. Root, devised a honey grader consisting of a frame of wood in which were mounted at intervals pieces of colored glass of different shades to duplicate approximately the colors of the principal commercial honeys. These pieces of colored glass, five in all, were placed at intervals, leaving spaces for a bottle of honey. This bottle was placed in the hole nearest to the shade of glass it matched. If, for example, the honey in the bottle matched the "light-amber" glass, it was classed as a light-amber honey, and so on. If the honey was lighter than the light-amber glass and darker than the next glass, classed as "white," it was called light amber still because it was not quite up to a white and, of course, should not be classed as such.

This grader was used quite extensively a few years ago. It was finally taken off the market because of the difficulty of getting more glass of the right colors. A good spectacle glass will not fade,

but is expensive and hard to get in the exact shade of color; but even this grader might not give the exact shade of the honey. In place of colored glass, bottles of colored liquids have been used, but all liquids will fade worse than glass. Why not use bottles of honey? Honey will granulate. When liquefied it will be a shade darker. Back of this grader there was no official sanction either from the United States government or from any national organization of beekeepers. Moreover, the exact shade of color could not be accurately classified, but only approximately, because with the Root grader there were only five shades, whereas commercial honeys may have from ten to twenty-five or more.

To overcome these difficulties, the Bee Culture Laboratory of the Bureau of Entomology, in collaboration with the Bureau of Agricultural Economics, which has to do with the marketing of all farm products, has perfected a type of grader so designed as to determine the color grade of any sample of honey. The active principle of this grader consists of



The new government honey-grader.

an elongated wedge-shaped trough made of glass to receive a sample of the honey to be graded. This in turn is to be compared with an inversely placed wedge of amber glass. As this glass varies in thickness from one end to the other the degree or density of amber color will vary according to the thickness. At the thick end the color will be the darkest amber and at the other end (the thinnest) the shade will be almost water-white with a slight suggestion of yellow. In between these there will be all shades of amber, depending on the point on the wedge-shaped glass at which the comparison is made. To find the exact shade of the honey, the two wedges, one of glass and the other of honey, are viewed simultaneously, through a vertical slot or window with the background of a blue sky. By means of a rack and pinion operated by the knob beneath, the wedge of honey is moved back and forth. When the two colors or shades exactly match a reading in millimeters is taken.

While the reading gives the exact shade in millimeters this can not be used unless the other party (the buyer) has a grader like the one here shown. For the buyer who has no such instrument the nearest color designation is taken—for example "white," "light amber" or whatever it may be. These are indicated on the scale itself.

The objection to this grader is its cost. It is made by a maker of scientific instruments and costs $40.00. Probably no individual beekeeper would buy one unless he were a carload producer; but beekeepers' associations, colleges, and schools could each own one. All samples of honey could then be sent to the nearest station and its report used in making a sale.

This government grader could also be used for checking up cheaper grades that may be on the market.

The Density or Specific Gravity of Extracted Honey

The density of honey is usually determined by the number of pounds to the gallon. A standard honey suitable for market should not run less than 12 pounds to the gallon at 60° F., which would be 50° on the Baumé scale or 75° on the Brix. The average beekeeper will be compelled to rely on the proper gallon weight. Honeys running as low as 11½ or 11¾ pounds to the gallon are too thin because they may ferment. (See Extracted Honey and Granulated Honey.)

Flavor of Honey

While merely naming the source of the honey is sufficient to indicate the flavor, it is much more accurate—certainly more satisfactory to all parties—to send a sample by mail. Not all good clover, basswood, sweet clover, alfalfa, or orange honey are equal in flavor. Some honeys

	1	2	3	4	5	6
GRADE	PHYSICAL CHARACTERISTICS OF THE HONEY IN THE COMB	COLOR OF THE HONEY IN THE COMB	COLOR OF COMB AND CAPPINGS (d), AND FREEDOM FROM EXCESSIVE PROPOLIS AND PRONOUNCED STAINS (e)	WOOD OF SECTIONS AND APPEARANCE AND KIND OF CASES	COMBS PROJECTING BEYOND WOOD OF SECTION (i)	SURFACE OF COMBS
United States Fancy...	Free from pollen cells. Free from damage (a) caused by granulation, honeydew, poorly ripened or sour honey, any objectionable flavor from floral source, taint of smoke, carbolic acid, other foreign flavor, odor or other means.	Uniform (b).......	See color chart (c)..	Sections shall be new in appearance (f) and white wood (g) Unless otherwise specified, sections shall be well packed (h) in new 24-section cases.	Free from .	Must be dry, free from any sign of weeping (j), and from damage by bruising (k) or other means.
United States No. 1 (see footnote below).	Free from pollen cells. Free from damage (a) caused by granulation, honeydew, poorly ripened or sour honey, any objectionable flavor from floral source, taint of smoke, carbolic acid, other foreign flavor, odor or other means.	Uniform in two-thirds of combs in a case and fairly uniform (b) in one-third of combs.	See color chart (c)...	Sections shall be new in appearance, white wood, well packed in cases of new appearance, and, unless otherwise specified, in 24-section cases, see exception on page 3, Sec. 4	Free from.	Must be dry, free from any sign of weeping (j), and from damage by bruising (k) or other means.
United States No. 2...	Free from serious damage (a) by pollen cells or any other item above except that granulation is not a serious damage in this grade	No requirements	See color chart (c)	Unless otherwise specified, sections shall be new in appearance (f) and of white wood (g).	Free from..	Must not be badly bruised, marred, or leaking; holes cut in cappings or small broken surfaces permitted.

are much better than others. Other things being equal, a honey, either comb or extracted, that is fully ripened on the hive, every cell of which is capped over, is superior to a thin honey thickened and ripened in open tanks or vats. The longer the honey is on the hive after capping, the more mellow the flavor; but comb honey, if left on till the cappings are travel-stained or darkened, will not bring as good a price—not because the flavor is impaired, but because the appearance is not as good.

The flavor of honey may be greatly injured if the honey has been heated too hot or too long. Honey should never be heated above 160° F. for bottling or canning. (See Bottling Honey, Granulated Honey, and Extracted Honey.) See also Circular No. 24, United States Department of Agriculture, December, 1927, entitled "United States Grades, Color Standards, and Packing Requirements for Honey." So much for grading liquid or extracted honey.

Grading Comb Honey

Grading comb honey is an altogether different proposition. Besides the honey in the comb there is the comb itself, the cappings, color of the cappings, weight, and general appearance. Comb honey is usually classified as "Fancy," "No. 1," and "No. 2" or "Choice." Some add the grades "Extra Fancy," and still another grade, "Culls."

Various sets of grading rules for comb honey have been proposed. Attempts have been made to adopt rules that would be standard for all parts of the country; but, on account of the difference in localities and kinds of honey produced, it has been difficult to do this. In the Rocky Mountain regions the honey is practically all white—mainly alfalfa and sweet clover. The honey flow is steady and strong. In the eastern states the flow is intermittent or irregular and the color all the way from buckwheat to white clover. It is easier to reach certain standards in the West than in the East, and for that reason two sets of grading rules have been more or less in vogue.

The following are a set of rules adopted by The A. I. Root Company and are based on eastern rules:

Honey Grading Rules—Comb Honey

In harmony with the Federal net-weight regulations and the statutes of many states, all comb honey is figured with the weight of the sections excluded. To get the net weight, deduct the weight of the empty case and 1 pound 8 ounces for the weight of 24 sections. (Approximately 1 ounce each.)

It is, of course, understood that the liquid honey contained in these comb-honey grades will be from white to water-white in color, and in describing comb honey it is always very important to name the flavor, that is, "white clover," "basswood," "mesquite," "orange," etc.

Fancy—Sections to be evenly filled, comb firmly attached to the four sides, the sections free from propolis or other pronounced stain, comb and cappings white, and not more than six unsealed cells on either side exclusive of the outside row. The sections in this grade must average not less than 12½ ounces net, and no section weigh less than 12 ounces net.

No. 1—Sections to be evenly filled, combs firmly attached to the four sides, the sections free from propolis or other pronounced stain; comb and cappings white to slightly off color, and a total of not more than forty unsealed cells, exclusive of the outside row. The sec-

7	8	9	10		
ATTACHMENT OF COMBS "Well attached" means that one half of the possible area (l) must be attached. "Firmly attached" means that three fourths of the possible area must be attached.	THROUGH HOLES AND DRY HOLES	OPEN AND EMPTY CELLS, CAPPING OF CELLS	MINIMUM NET WEIGHT	TOLERANCE FOR DEFECTS	TOLERANCE FOR WEIGHT
If outside row of cells next wood is empty, each comb must be firmly attached (l) to all four sides. If outside row is filled with honey, the comb must be well attached (l) to all four sides.	In three-fourths of sections 2¼ linear inches of through holes (m) permitted next wood, in one-fourth of sections 2¾ linear inches through holes permitted. No dry holes (m) permitted in body of comb.	All cells other than outside row next wood must be evenly capped (n). Open or empty cells (o) permitted only in outside row next wood.	12 ounces net (p) unless otherwise specified.	5 per cent tolerance but not more than two-fifths of this for serious damage (a)	5 per cent tolerance but no section shall be more than one-half ounce below the minimum net weight.
Each comb must be well attached to all four sides.	In three-fourths of sections 3¾ linear inches (m) of through holes permitted next wood, in one-fourth of sections 4¼ linear inches through holes permitted. No dry holes (m) permitted in body of comb.	Cappings shall be even (n) except for slight irregularities of surface affecting not to exceed one-half of comb surface. Open cells are permitted in outside row next wood, and in addition one-half of sections in any case may have open cells at any corner, along lower edge, or in row of cells adjoining outside row. Open cells, exclusive of outside row, shall not exceed 25 in number on comb weighing over 12 ounces net (p), or 12 open cells on comb weighing between 11 and 12 ounces, inclusive. Of total number of open cells, exclusive of those in outside row, not more than 6 may be empty (o).	11 ounces net (p), unless otherwise specified.	5 per cent tolerance but not more than two-fifths of this for serious damage (a).	5 per cent tolerance but no section shall be more than one-half ounce below the minimum net weight.
Each comb must be well attached . .	In three-fourths of sections 6 linear inches of through holes (m) permitted next wood, in one-fourth of sections 6½ linear inches through holes permitted. No dry hole (m) larger than ⅜ inch across is permitted if it extends more than 1⅜ inches from the wood.	Cappings may be uneven. Open cells (o) are permitted in outside row next wood, and in addition each comb may have not more than 50 open cells on a comb weighing over 11 ounces net, or 20 open cells on a comb weighing between 10 and 11 ounces, inclusive. Not over 5 open or empty cells permitted on body of comb, away from open cells at corners or edges. Of total number of open cells, exclusive of those in outside row, not more than 20 may be empty	10 ounces net (p), unless otherwise specified.	5 per cent tolerance	5 per cent tolerance but no section shall be more than one-half ounce below the minimum net weight.

GRADE	OVERHEATING, FERMENTATION, HONEYDEW, POLLEN, OBJECTIONABLE FLAVOR FROM FLORAL SOURCE, TAINT OF SMOKE, CARBOLIC ACID, OTHER FOREIGN FLAVOR, ODOR, OR DIRT OR OTHER MEANS	WEIGHT OR DENSITY (Page 25)	COLOR (Page 26)
United States Fancy. .	Free from damage (a) by above.	Not less than 12 pounds per gallon at 60° F	Any standard color as measured by the color grader
United States No. 1. . .	Free from damage (a) by above.	Not less than 12 pounds per gallon at 60° F	Any standard color as measured by the color grader.
United States No. 2 .	Is honey which does not meet the requirements of Fancy or No. 1		

8—6077

CLEARNESS (Page 25)	CONTAINERS	TOLERANCE FOR DEFECTS
As clean as though strained through 86-mesh bolting cloth at not over 140° F	Strong, clean, new in appearance (f)	5 per cent, but none for serious damage
As clean as though strained through 23-mesh bolting cloth at not over 140° F	Strong, clean, new in appearance (f).	5 per cent, but none for serious damage

tions in this grade must average not less than 10½ oz. net and no section weigh less than 10 ounces net.

No. 2.—Combs not projecting beyond the box, attached to the sides not less than two-thirds of the way around, and a total of not more than 60 unsealed cells, exclusive of the row adjacent to the box. The sections in this grade must average not less than 9½ ounces net, and no section weigh less than 9 ounces net.

Culls—Honey packed in soiled, second-hand cases or honey in badly stained or propolized sections; sections containing pollen, honeydew honey, honey showing signs of granulation, poorly ripened, sour or "weeping" honey; sections with combs projecting beyond the box or attached to the box less than two-thirds the distance around its inner surface; sections with more than 60 unsealed cells, exclusive of the row adjacent to the box; leaking, injured or patched-up sections; sections weighing less than 9 ounces net. (Note—It is advisable to retain the sections of this grade for bait sections or for local sales.)

In the West the Colorado grading rules have been used quite extensively and are as follows:

Comb Honey Grading Rules

Extra Fancy—Sections to be well filled: combs firmly attached on all sides and evenly capped, except the outside row next to the wood; honey, comb and cappings white, or slightly off color; combs not projecting beyond the wood; sections to be well cleaned; no section in this grade to weigh less than 12½ ounces net, or 13½ ounces gross. The top of each section in this grade must be stamped, "Net weight 12½ ounces or more."

The front sections in each case must be of uniform color and finish and shall be a true representation of the contents of the case.

Fancy—Sections to be well filled; combs firmly attached, not projecting beyond the wood and entirely capped, except the outside row next to the wood; honey, comb and cappings from white to light amber in color; sections to be well cleaned, no section in this grade to

weigh less than 11 ounces net, or 12 ounces gross. The top of each section in this grade must be stamped, "Net weight 11 ounces or more."

The front sections in each case must be of uniform color and finish, and shall be a true representation of the contents of the case.

Choice—This grade is composed of sections that are entirely capped, except row next to the wood, weighing not less than 10 ounces net, or 11 ounces gross. Also of such sections that weigh 11 ounces net or 12 ounces gross, or more, and have not more than 50 uncapped cells altogether, which must be filled with honey; honey, comb, and cappings, from white to amber in color; sections to be well cleaned. The top of each section in this grade must be stamped, "Net weight 10 ounces or more."

The front sections in each case must be of uniform color and finish and shall be a true representation of the contents of the case.

Neither of these sets of rules is standard for the whole of the United States, and neither is flexible enough to take in all honeys. Circular No. 24, of the United States Department of Agriculture, goes into this matter of the grading of all honeys very fully. It sets forth the work of the Bureau of Agricultural Economics (which has to do with markets) and the Division of Bee Culture Investigations in the Bureau of Entomology in preparing a set of rules that covers all honeys, whether comb or extracted, for the whole of the United States. As it would be impossible to publish the whole of this circular, the accompanying chart, reproduced on two pages, will give a summary of how comb honey can be accurately graded.

One should write to the Bee Culture Laboratory, Bureau of Entomology, for a copy of the "Color Chart" referred to in column 3, and it would be well to ask for Circular No. 24 at the same time.

It is needless to say that if all beekeepers of the country will accept these gradings it will save not a little misunderstanding between producer and buyer, or between seller and buyer. Whether beekeepers will adopt the government standards remain to be seen. Even if the rules are not as simple as some others, any food product, especially honey, if sold under United States grading rules will have an advantage over foods not so graded. The government will furnish a rubber stamp for marking all honeys graded by the United States rules.

GRANULATED HONEY.—Nearly all kinds of liquid honey and most comb honey, if given time enough, are liable to cloud and partially solidify at the approach of or after cold weather. The honey assumes a granular mealy condition something like most fine brown or raw sugar. The granules may be about the size of grains of ordinary table salt, or they may be much finer. *Comb* honey granulates less readily than extracted, and only after a much longer period. While cold weather is much more conducive to solidification, yet in some localities, and with some honeys especially, the granulation takes place even in *warm weather.* Some honeys will granulate in a month after being taken from the comb, and others will remain liquid for two years. A honey that granulates quickly is extracted alfalfa, the action taking place in from three to five months. Mountain sage from California and tupelo from Florida may remain liquid for several years.

Ordinary comb honey in sections, if well ripened, will usually remain liquid as long as the weather is warm. After that time, especially if it has been subjected to cold, there are likely to be a few scattered granules in each cell. These gradually increase in number until the honey and the wax become almost one solid mass. In such condition it is unsuitable for the market, the table, or for feeding back, and should be treated by the plan described farther on.

The Science of Granulation

Dr. E. F. Phillips, professor of bee culture at Cornell University, explains granulation as follows:

What Happens When Honey Granulates

Honey, being essentially a mixture of solutions of the three sugars, behaves somewhat unlike any one of the three sugars in single solution, yet on the whole the behavior of the sugars is typical of each. Dextrose, being a quickly granulating sugar, usually begins to form crystals in a short time. Sucrose is present in honey in small amounts (never more than eight per cent in normal honeys), and such a weak solution does not quickly form crystals. Levulose, being a non-crystallizing sugar, remains in solution. When crystals form in honey, it is then the dextrose which is taking crystal form, and the other sugars remain in solution.

When one sees a can of honey solidly granulated, it would appear that all the sugar present in the honey has become hard, but this is not the case. The dextrose crystals are each surrounded by a thin, microscopic layer of sugar solution and the levulose and sucrose are still present in solution. The other constituents of honey, such as mineral material, coloring material, and other things which give honey its mysterious virtues as a food, are still in their original form, and it is only the dextrose which has taken on solid form. From this one might readily infer that a honey which contains a relatively large proportion of dextrose would granulate most quickly, while one which is relatively deficient in dextrose would remain in liquid form longer, or perhaps not granulate at all. This we find actually to be the case when analyses of honey are compared.

Alfalfa honey is relatively high in dextrose and granulates quickly, while sage and tupelo honeys are high in levulose and low in dextrose and they are called non-granulating honeys.

Combination of Different Sugars Retards Granulation

These elementary facts about honey do not tell the whole story, however, for honey-granulation is more complex than has been indicated. If one were to make a solution of either dextrose or sucrose of 75 per cent, which is about an average sugar density for honey, he would expect crystals to form quickly, beginning almost as soon as the solution became cool. Honey does not begin granulation that quickly, but remains liquid for days, weeks, or even months after extraction. It has been found that the percentage of sugar alone does not govern the rate of granulation, but that the ratios of the sugars to each other has an influence. The fact that honey contains three sugars, two in considerable proportion, has a marked tendency to retard granulation. This is a complex physical phenomenon, but if this were not the case all our honeys would granulate before we could get them extracted, and extracted honey production would be impossible. Nature provides not only a complex chemical laboratory for the manufacture of honey, but this same laboratory gives us demonstrations of intricate and complex physical experiments in the daily run of things in the apiary.

Cause of Coarse or Fine Crystals

The coarseness of granulation also varies considerably, and this is often a puzzle to the beekeeper. Dextrose crystals are not so clear-cut and definite in shape as are many organic or inorganic crystals, but are irregular in form. If they form quickly, each crystal is small, whereas if crystal formation proceeds slowly, the crystals first formed increase in size. The coarseness of granulation is therefore a factor of the speed of crystal formation. If one desires a fine granulation, it is well known that stirring helps. Also crystal formation is increased in rate if the temperature changes frequently and sharply, so that exposure of honey to changing temperatures tends to cause the formation of fine crystals. Of recent years a number of different methods have been devised for the making of honey butter, or the same product under different names, in which the dextrose crystals are exceedingly small, making a smooth, soft product. One method consists of the grinding of the dextrose crystals, but in most methods the granulation is simply speeded up so that all crystals are minute. The amazing thing is that the taste of the honey is changed by the size of crystals, but that is another story.

There is another factor that may or may not have an influence in starting or hastening granulation, and that is, one of the yeasts found in honey. It is known that a temperature of 160° F. kills these yeasts. It is also well proven that the same temperature arrests or stops granulation. (See Yeasts in Honey, also Bottling Honey.)

By turning to Yeasts in Honey it will be noted that it is possible that one or more of the several yeasts in honey may have an influence on granulation. Be that as it may, a temperature of 160° F. will kill all yeasts. It will likewise prevent granulation for a year or more, provided the honey is sealed while hot. It will take more work before the relationship, if any, can be definitely established.

As explained under Extracting, some beekeepers at the close of the season store their wet combs from the extractor in the honey house and do not put them on the hives until the next extracting season. Unless these wet combs are cleaned up by the bees before storing for the next year, the thin varnish of honey on the insides of the cells will form crystals of granulation. This seed will very soon start granulation on the first extracting of the next season. The first extracting of honey will granulate quicker than that which comes from the second or subsequent extracting.

Of course, there are conditions where it might be advisable to have the honey granulate as quickly as possible because honey in the granulated form will ship better than honey in a liquid condition.

From what has just been said by Phillips and by Wilson under Honey, Spoilage of, liquid honey if well ripened will be less liable to ferment than granulated honey.

On the whole the author advises that all extracting combs at the close of the season be put on the hives to be cleaned up by the bees. Never expose them to robbers in the open air on the hives to be cleaned up before storing. (See page 65.) It is desirable to keep honey from granulation as long as possible. It will assume the crystallized state soon enough. (See Honey, Spoilage of, and Honey, Science of.)

There is no plan to prevent honey from granulating or to restore a granulated honey to a liquid condition except by the use of heat; but it should be made emphatic that in the employment of steam, hot air or hot water, one may seriously impair the flavor of a good honey or ruin it altogether unless great care is taken. If the temperature goes too high, or if a low heat is maintained too long, the honey will be made several shades darker in color and the flavor will be greatly impaired or ruined beyond recovery. Much of the honey on the market sold by individual beekeepers or by small packers is of inferior quality just because heat was improperly used.

Dr. E. F. Phillips, referred to in numerous places in this work, regrets that much of the honey sold, good before it was processed to prevent granulation, is so poor that the housewife will not buy

even a good honey, fearing that it will be no better than the poor stuff on the pantry shelf that the family won't eat.

Carelessness or lack of knowledge on how to process honey on the part of the small packers will react on the honey market, and also, of course, on the beekeeper.

The author believes that while most of the honey in groceries and in the roadside stands is of fair to good quality, a word of caution should be here offered to the beekeeper and to his customer to use heat in the processing of his honey intelligently.

That means that the directions here given should be followed very carefully. The temperature of the honey should not go above 160° F., and then should be cooled as quickly as possible. It should never under any circumstances be kept hot long. In order to watch the temperatures, it is essential to have a tested thermometer. The ordinary house instruments are not reliable for such work. A good dairy thermometer that can be had at hardware stores answers an excellent purpose for the beekeeper or the small packer. If not marked "tested," it should be compared with some tested thermometer and the correct reading point for 160° F. should be marked. This is near the danger point in heating honey, and it is highly important that it should be accurately indicated. (See article by Prof. Richmond in Gleanings, page 747, December, 1932.)

Where there is a large amount of granulated honey to be rendered as in the case of the large honey packers or large honey bottlers, a special thermometer should be used. One such can be obtained from scientific instrument makers. The Taylor Instrument Company, Rochester, New York, make a specialty of thermometers for all purposes. State the purpose for which it is to be used and the range of readings desired.

Emphasis can not be made too strongly that the honey on reaching the 160° mark should, if the crystals of granulation are all dissolved, be sealed immediately in the bottle or tin can and then *cooled* as soon as possible. Sometimes a cool or cold atmosphere is sufficient, at other times running water, from a well or a tank of water kept cold with ice should be used. The containers as soon as sealed should be placed in the water and when cooled properly labeled.

Equipment for Liquefying Granulated Honey

Under Bottling are given some simple methods of doing this work; but where large amounts of granulated honey are to be reduced to a liquid condition some special equipment will have to be provided.

In melting honey the heating agent, steam, gas, coal, or wood fire, must not come in contact with the can holding the honey, as it would scorch it and ruin its flavor. To prevent this, it is customary to use hot water or hot air. The water should never be hotter than 165° F., or the air should not go higher than 180° F., and then only for a short time. Be sure the honey goes no higher than 160°. To liquefy only and not for bottling it is safer to keep under 150° F., and even then the heat should not continue longer than necessary to melt all the crystals.

When water is used a double boiler with hot water between the two walls can be placed on an ordinary stove. A cheaper outfit is a square galvanized tank just large enough to take four, six, or eight 60-pound square cans at a time, and yet leave a clearance all around each can of about an inch for circulating water. The tank should be about four inches deeper than a square can, and then enough water is put in to nearly submerge the 60-pound cans when in place. If the boiler or tank is put on a stove or brick arch a frame of wood should be put under the cans to prevent the fire from coming in direct contact with the honey.

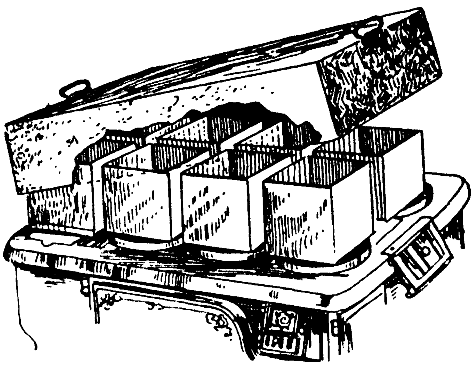
If the tank is heated on a common stove it can not take in more than four 60-pound cans at a time. Where it is larger it is customary to use a jet of steam from a small agricultural boiler that can be bought for a moderate sum from a mail-order house. A boiler is almost a necessity where large amounts of honey or wax have to be rendered.

Whatever heat is used it will require a constant temperature of 140° or 150° F. for 24 hours to melt all the honey. In the meantime the caps must be removed from the 60-pound cans and put on when the work is done.

Another excellent way of melting from 500 pounds to a ton of granulated honey is to put the square cans in a hot room with a low ceiling, with a sufficient amount of steam pipes around three sides of the room to maintain a temperature of

150° to 160° F. for 24 hours or longer. The cubic capacity should be no larger than enough to house a certain number of cans at a time to save heat. The hot-room method is the one usually employed where large amounts of granulated honey are to be melted. It is cleaner, cheaper, and handier.

Where one desires to use the hot-air scheme for one or two hundred pounds there is nothing cheaper or better than the Dayton plan. By turning to Cans at the close of the subject the reader will learn how one in a few minutes with a common hive-tool and a hammer can convert 60-pound square cans into receptacles for melting honey. Four, six, or eight of



Dayton's hot air outfit for liquefying honey.

these can be put on top of a common stove at a time. Under each 60-pound can should be put a small ring of band iron to keep it from direct contact with the fire. A metal or, what would be much cheaper and just as good, a wooden cover can be set over all to hold the heat. A thermometer should be immersed in the various cans of honey to note the temperature. It should never go above 160° F.

When the stove is large enough 200 pounds of honey can be melted at one time with a minimum of expense for equipment. A slow, steady coal fire should be kept up until the honey is melted. Wood would be too quick and flashy for a steady fire. A gas, gasolene or kerosene stove will furnish a slow steady heat but only one 60-pound can could be put over a burner at a time, having the flame turned low to avoid scorching the honey. (For melting honey on a small scale see Bottling.)

Marketing Granulated Honey

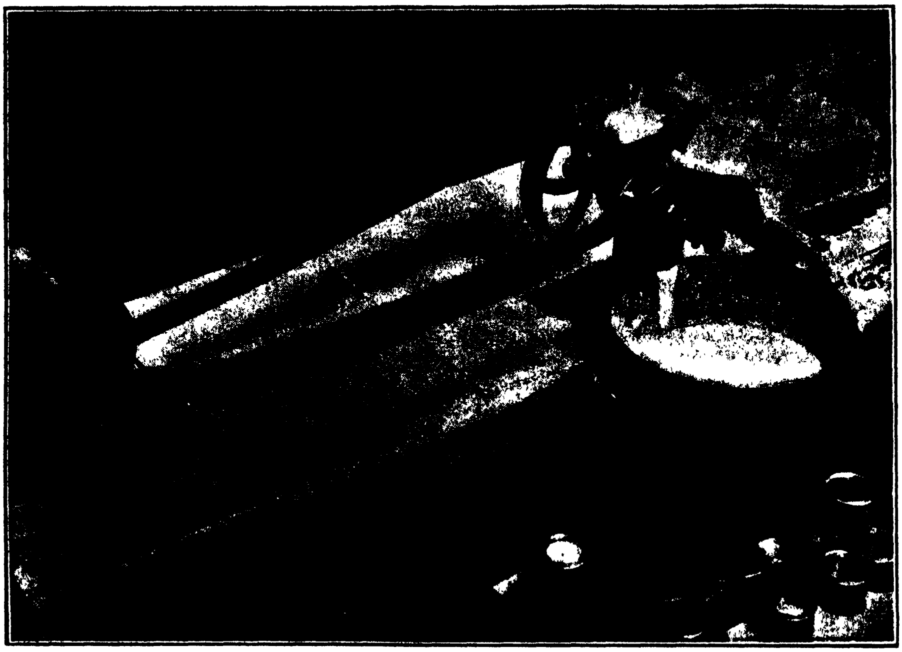
That natural granulated honey is delicious and fine as a spread on bread and butter, every beekeeper knows. Many prefer honey either granulated or in a semi-solid condition. If the general public—and that means the housewife—knew this, and that it was not adulterated or "gone back to sugar," there would be no difficulty in selling it; but the general public does not know. It is suspicious, and when extracted honey in bottles or cans begins to granulate the housewife jumps to the conclusion that it is adulterated. Sometimes she will throw it into the garbage can as "not fit to eat." Even if she does not she will buy no more of it, and will class the poor beekeeper who sold it to her as a fraud. She may even refuse to buy any liquid honey, no matter how attractive, fearing it will "go back to sugar" on the assumption that all honey is adulterated.

The author, in a four-year Redpath Chautauqua lecture tour in thirty different states, meeting face to face many thousands of the most educated and refined women of the country, met over and over again the heresy of honey "going back to sugar." There is no question that there is a very strong prejudice in this country against granulated honey, and the sooner beekeepers recognize this sales resistance and act accordingly the better it will be for the industry.

There should be an explanation on every package of extracted honey that this or any pure honey may granulate in a few weeks after the package is opened, especially if it is stored in a refrigerator or any cool place. Then if it does granulate the housewife will accept the fact. On the larger packages it should be further explained that partly granulated honey is just as pure as liquid honey; that many people, knowing this fact, prefer to eat it in the semi-solid condition; and when liquid honey is preferred, how this partly granulated honey can be restored by heat.

In Canada and in Europe there is not this prejudice against granulated honey or honey partly granulated, because the bulk of the honey is sold in five and ten pound pails.

While there have been various schemes for putting up ordinary granulated honey in oyster pails, paper milk bottles, and the like, the best way to market granulated honey is in tin. A glass package is not suitable, because the contents look like lard. Pails are relatively cheap, and,



Granulated honey is put through a small meal or flour grinder. The result is a beautiful white creamy product that remains in the same condition for several years.

after the honey has been removed, are useful articles around the house. If these honey-pails are lithographed in colors with suitable wording about granulation, honey will be constantly advertised, even though the container is used for other purposes. School children and the workmen of the factories in Canada often carry their lunches in lithographed pails with the word "honey" displayed in big letters. In this way a large amount of free publicity is secured for honey, especially for honey in the granulated form.

Lithographed honey-pails are used almost universally in Canada, and are fast being adopted in the United States. The more they are used the more will the old prejudice against granulated honey be removed. (See Extracted Honey.)

There is one objection against coarse crystal granulated honey. Much of it is as hard as a brick. It is too hard to use as a spread on bread and butter without restoring it to a mushy or liquid condition.

The Root Cream of Honey

For a period of ten years, The A. I. Root Co., also publishers of this work, sold what it called "Cream of Honey." Unlike ordinary granulated honey, from which it was made, the new product was soft and creamy and yet hard enough so that it would not run or drip off the slice of bread. The flavor was actually improved and it seemed as if it would carry the market by storm; but it failed to do so. The housewife, the general arbiter of foods for the home, was suspicious. The creamy white product, which she admitted was delicious, didn't look like honey. She thought it was "adulterated." The A. I. Root Company saw that it would take an immense amount of advertising to overcome this sales resistance and so it decided to devote its energies to creating a demand for the regular comb and extracted honey. It continued to sell its cream of honey as opportunity offered.

The product as made and sold by The A. I. Root Company should not be confused with a honey cream, made by beating or whipping liquid honey with an egg beater until it becomes creamy white. At ordinary living room temperatures the air beaten into the honey may rise to the top in two or three weeks' time, leaving the clear honey below as it was before, or it may start to granulate and continue to do so until the whole mass looks and tastes like the products described on next page.

How to Make the Root Company's Honey Cream

The process is simple and the equipment is inexpensive. For experimental purposes one can take a small home coffee grinder and grind up ordinary granulated honey into a soft pulpy mass. A small hand grist mill such as one can buy of the mail order houses for four or five dollars, is much better. With one of these machines one can grind up by hand enough cream of honey to take care of a local trade. A little larger mill driven by a small electric motor as shown in the illustration will furnish enough cream of honey for a large territory.

The product can be greatly improved by mixing in with the ground-up mass about 20 per cent of liquid honey. A non-granulating honey like tupelo or mountain sage is better for the purpose. With this addition of liquid honey the cream becomes wonderfully smooth, soft and just right to spread on bread and butter. It is important to have the liquid honey well incorporated. To that end the mixture can be run through the mill the second time or well beaten in with a paddle. For further information see page 360, Gleanings in Bee Culture, 1927, and again Gleanings, page 268, 1934.

Honey Nut

Nuts of various kinds can be put in the hopper of the grinder at the same time the granulated honey is added and all ground together. The proportion of nuts to the honey should be small—just enough to give the cream a nutty flavor. Of course, the proportion can be varied to suit the individual taste. The combination of the nuts and granulated honey makes a very delicious confection or spread for bread — a fine substitute for jellies and jams. Honey nut makes a nice filler for honey chocolate candies. (See Honey Candies.)*

Either honey nut or honey cream, just described, is made from an unheated honey. As has been pointed out elsewhere in this work in numerous places, the heating of honey does not improve its flavor and very often injures or ruins it. This is one reason why discriminating consumers prefer an unheated honey or honey just as it comes from the hive. A processed or bottled honey, as is well known, often lacks the flavor of extracted honey just from the extractor or as found in comb honey. On the other hand, it must be acknowledged what Phillips points out in his description of the Dyce method that an unheated honey especially after it is granulated may ferment or sour. Theoretically a honey cream made by grinding an unheated granulated honey may later on ferment or sour; but in the experience of The Root Company in making and selling it for over ten years it did neither and we had some samples that were eight and ten years old. When it was that age the liquid phase came to the top; but digging down into the mass the product was still good. There was no spoilage of any kind except in appearance.

Cream of honey as made by the plan just described should be sold as soon as possible. Even that made by the Dyce process probably will show water on top after aging. Several samples that the author has seen has done this although Phillips maintains, that if made right, it should not do so. It will be wise for the grocer to err on the safe side and sell it.

New Zealand Creamed Honey

There is still another process of making creamed granulated honey that has been made and sold in New Zealand for some time back. A correspondent for Gleanings in Bee Culture for September, 1934, thus describes it:

> Most of the honey consumed in New Zealand is sold in granulated form, liquid honey being considered by most people as being too messy to use. No liquid honey can be exported from New Zealand as such: it must be all granulated firm, perhaps to be reconditioned to serve the tastes of the ultimate purchasers.
>
> The finer and smoother the granulation, the higher the grade, other conditions such as flavor, color, and freeness from scum and air bubbles being equal.
>
> When the honey is placed in the tank it is strained and clarified by allowing the air bubbles, fine grains of wax and pollen to rise to the surface, the honey being skimmed until no more scum rises. The honey is well stirred several times to assist in the clarifying. If the temperature is very changeable, granulation may start in a few days and it may be coarse or fine, usually coarse. To be sure of a fine granulation we mix ten pounds or more of finely granulated honey as a starter to every half ton of liquid honey, and if thoroughly mixed the whole tank will granulate fine and smooth.
>
> When granulation has well started the honey can be run off into whatever containers are used.
>
> We use containers holding from one pound to sixty. If sixty-pound tins have been allowed to granulate coarse, these can be liquefied by placing in water 140° F. until melted, then pour into a tank and use the fine starter as above.
>
> If the small producer has no starter suitable he can buy some or try grinding down some

*Caution.—Honey nut creamed honey should not be allowed to stand too long before it is consumed, as it has a tendency after standing to become rancid. It is advisable not to make up too large a quantity at a time.

coarse honey.—G. H. Keen, Woodbury, South Canterbury, N. Z.

This creamed product may or may not be the same as the Dyce. The essential difference is that in New Zealand constant stirring or agitation takes the place of refrigeration used by Dyce.

The Dyce Method for Making a Honey Cream

During 1930, Dr. E. J. Dyce experimenting with granulating honey, developed a product which though similar is probably superior to that just described by Mr. Keene of New Zealand. Later Dyce did some work on the process under Dr. E. F. Phillips at Cornell University during which he perfected the details for making a honey cream. While the product so far as flavor, texture and taste is concerned, is practically the same as the ground up hard granulated honey just described, yet from the standpoint of the commercial honey packer it is much easier and cheaper to process by the Dyce method of refrigeration than by grinding or by stirring as practiced in New Zealand.

It has been recognized from time immemorial that nature has been giving us two kinds of granulated honey—one a hard coarse crystal grain honey and the other a fine smooth semi-soft small crystal product. The first mentioned is too hard to spread on bread, requires a stiff bladed knife or trowel to handle, and the other has a smooth velvety taste and can easily be spread like soft butter on bread. No one seemed to know why there should be such a difference between the two kinds until A. Gubin of the Moscow Apicultural Station in 1926, showed in *Archiv fur Bienenkunde*, that the one, the coarse and hard granulation, was due to the slow crystallization, and the soft and smooth to rapid formation of crystals. His observations are thus summarized in the Bee World for January-February, 1927, page 132 and 133.

1. The crystallization, generally rapid, of extracted honey depends on the greater or smaller number of "primary crystals," which can only be seen with the help of the microscope and weak illumination; better, polarized light.

2. Primary crystals occur in honey in sealed comb. They are scarcer in new combs than in old ones.

3. If there are many primary crystals, the honey granulates soon and is of fatty consistency; if few, the crystals formed are much larger.

4. When honey is warmed, the primary crystals are dissolved, and the granulation takes a long time and becomes coarse grained.

5. Temperature and time needed to dissolve the crystals in already granulated honey depend upon one another. The least temperature for complete dissolution is 35° c., but some honeys need a higher temperature, and in practice it must not be lower than 45° (118° F.).

6. Honey that has been warmed granulates quicker if (a) some crystals are put in; (b) water evaporates quickly from the surface. (The grain, it appears, is finer if evaporation be encouraged; and generally, quick granulation and fine grain are associated.)

7. Crystals from upper layers spread through the honey because their specific gravity is greater than that of the honey. Their rate of fall (8) depends on temperature and size of crystals.

9. Honey, warmed and sealed up hermetically and kept at under 0° c., granulated at the same time as control honey of same kind in the laboratory. The temperature differences (+15° c. in the laboratory, down to —15° c. [27 degrees F. of frost] under the roof) made no difference. These experiments are being repeated.

10. Sunlight produces a coarse crystallization more quickly.

11. Putting in sugar, rubbing a glass rod on sides of vessels, aeration of the honey (even with dusty air) made no difference.

12. If crystals are put into warmed honey, the nature of the granulation depends on the method used. Stirring distributes the crystals and gives a finer grain.

13. The protection of the free surface of the honey from evaporation, in order to get large crystals, can be done in several ways, and need not be hermetic.

14. If bees are fed on extracted honey in autumn, it must be warmed to prevent granulation in the combs during the winter.

Following Gubin, De Boer, a Dutch research worker, carried on the investigation still further. He not only confirmed Gubin but brought out many of the principles of coarse and fine granulation of honey. (See The Bee World for February, 1932, pages 14 to 18.) Apparently Dr. Dyce went further than either.

Although it has been stated that controlled granulation has been practiced in New Zealand for years, it does not appear from the matter above quoted that Gubin or De Boer, gave enough details to enable a commercial honey packer to make a constantly uniform small crystal product as worked out by Dr. Dyce.

Dr. E. F. Phillips, under whom Dr. Dyce worked, thus describes in detail the full Dyce process as given in Gleanings in Bee Culture, page 13, for 1932:

Relation of Fermentation to Granulation

When honey granulates, part of the dextrose which it contains forms crystals, and these crystals have a water content of slightly over 9%, always the same per cent because the water in the crystal is locked up as water of crystallization and thus becomes inactive as water. When part of the water in a honey is thus removed with the solid phase of a honey, the remaining part of the original water in the honey is now all part of the liquid phase, and since the water content of the crystalls is always less than that of the original honey, it follows by simple arithmetic that the water content of the liquid phase of the honey is higher than was originally the case with the honey as a whole. It is common for beekeepers to refer to a granulated honey as "solid," when as a matter of fact only a small fraction of the honey is in

solid form. The small proportion which has formed crystals serves as a supporting framework which gives the appearance of solidity to the entire mass.

Because of the increased water content in the liquid phase of granulated honey, fermentation practically always occurs in granulated honey and not in liquid honey. Since the water content of the liquid phase of granulated honey is higher, this gives conditions favorable to the growth of the sugar-tolerant yeasts which were present from the first. Then, whenever outside conditions, such as increased temperature, are suitable, fermentation begins. This explains why spoilage is greater in spring when the weather begins to warm up, than in fall or winter. The present necessity for holding honey for a longer time is therefore the economic cause of the increased losses from fermentation.

Methods of Preventing Fermentation

Various methods have been proposed for preventing honey spoilage, such as keeping it in cold storage (Marvin) or the use of preservatives (Lochhead). Both of these methods seem either impractical or undesirable, and no method has been suggested that fits the needs of the beekeeper as well as the time-tested method of heating honey to about 160° F., for at that temperature the yeasts are destroyed. When honey is bottled, this is the temperature commonly used in preparing the honey, and there is never any fermentation in properly bottled honeys. Of course this heating destroys the enzymes in honey also, but the more recent work in honeys indicates that the loss of enzymes is not a matter of importance. The possibility of darkening honey by overheating seems to be far more serious a matter than the loss of enzymes.

Coarse Crystals Objectionable in Granulated Honey

Unless a honey is hermetically sealed after being heated, granulation will probably occur again fairly soon in most honeys, and whenever granulation occurs in a honey which has once been heated, the crystals formed are almost invariably coarse, often making the honey unfit for table use. The practical problem in the control of fermentation is then to find some way of making the honey good after it is heated. This is the problem which Doctor Dyce has successfully solved, so that for the first time we appear to have a satisfactory means of controlling fermentation, while at the same time the honey can be made better to eat than ever before.

Unless honey is extracted from combs newly built from comb-foundation, there are always minute amounts of honey left in the combs from the previous crop. Almost without exception, this honey contains myriads of microscopic dextrose crystals, which have formed in the thin layer of honey since the combs were last used. When honey is again stored in these combs by the bees, most of these crystals are left and serve as "seed" for later granulation of the more recently stored honey. When combs are stored for the winter without being cleaned out by the bees, the number of included crystals is greatly increased, but still they are usually too small to be visible. Honey extracted only from newly-drawn combs usually granulates coarsely and is not so good to eat.

Rapid Granulation Gives Honey Creamy Appearance

When honey is heated, any crystals which it may contain are melted, so that the honey is then free of crystals. Without such "seed," later crystal formation is slow. It is a well known fact, for many other solutions as well as for honey, that when crystal formation is slow, the crystals formed are larger. This explains why honey that has been heated and later granulates is coarse without exception and why honey extracted from newly drawn combs is usually inferior.

It might then be suggested that it is desirable for honeys that are to be sold in granulated form not to heat them, but in this plan lies a serious danger. If granulation is encouraged in honeys that have not been heated, the percentage of spoiled honey is unusually large. In several batches of honeys that were not pre-

Dr. E. J. Dyce.

viously heated, and which were caused to granulate quickly by the process to be described later, every lot of honey fermented within a short time, so preliminary heating seems essential.

Since heating removes included crystals which would, if left, have caused quicker granulation, the obvious step after heating is to put crystals into the honey again. So after a honey has been heated to 160° F. to kill the yeasts, it should then be cooled as quickly as possible to a temperature which will not cause crystals to melt if a granulated honey is mixed with that which has been heated. Any temperature below 80° F., or even slightly higher, will do for this, but for working purposes a temperature of about 75° F. is about right. When this temperature is reached, there is to be added to the honey about five per cent of honey which has previously been caused to granulate quickly, or as we commonly say, previously processed honey. This "seed" must, of course, be honey which has been heated so that it contains no living yeast.

Best Temperature for Rapid Granulation

Having added the seed crystals in this manner, the honey is further cooled. The question now arises as to the temperature at which honey will form crystals most rapidly. A number of books on beekeeping state or have stated that a fairly low fluctuating temperature is most favorable for granulation, a statement of rather obvious incorrectness. Other erroneous statements have also appeared about temperatures favorable to granulation. For such a physical phenomenon as honey crystallization, it would naturally be assumed that there is one temperature at which this process will proceed most rapidly. At any rate the old statements of the effect of fluctuating temperatures or low temperature have been shown to be wholly wrong by Doctor Dyce's experiments.

From an extensive series of tests, Doctor Dyce found that for almost all honeys a con-

stant temperature of about 57° F. results in most rapid crystal formation. Every alert beekeeper will recall that 57° F. is the temperature at which bees form their winter cluster. It would be a serious strain on the imagination to surmise that any relationship exists between colony cluster formation and honey granulation, but it is made easier for the beekeeper to remember these two critical numbers because of their identity. For unusually thick honeys, such as a few that have been tested from the western states, a temperature one to two degrees higher may give increased speed of granulation.

Importance of Exact Temperature Control

The question now arises as to what effect a slight deviation from the optimum temperature will have, and Doctor Dyce's data give the answer. An increase or a decrease of two degrees often doubles the time necessary for complete granulation. When the temperature is kept at just the right degree, the result will be a container of honey that is ''solidly'' granulated in from two to four days, occasionally less than two days. If granulation takes as long as five or six days, because of the wrong temperature, the product is decidedly inferior, so that the most accurate temperature control is imperative for the making of a good granulated honey product

Where to Get the Seed

In all that has been given so far no reference has been made as to where to get the "seed" to start the granulation after the honey has been heated to kill the sugar tolerant yeasts. Most of the ordinary granulated honey available will have large crystals and such honey should not be used. If unable to find a small crystal honey one may secure a C. P. dextrose at the drug store and mix it with a honey that has been heated. This will produce a beautiful and fine granulation. Subsequent batches can be built up without the use of additional dextrose. When the seed is once secured there is no trouble about getting the right kind of product.

Or one can, says Mr. Keen, use for a "seed," finely ground coarse crystals of granulated honey. One would infer that the broken crystals re-form into small crystals.

As to the relative merits of the products from the four different methods here described for making honey cream it is not possible to pass an opinion. The presumption is that the Dyce cream on account of the quickness of the granulation through refrigeration, would have the finer grain. It could not ferment or sour.

But neither cream of honey by the grinding process, the New Zealand plan, or the Dyce plan or even old-fashioned granulated honey can be sold in this country without extensive advertising, or by face-to-face contact with the public, explaining what it is and how it is made. The public in this country is so suspicious of adulteration when any honey product, granular or white, is mentioned that it must be educated when any new honey food is offered.

It is right here that roadside stands (see Marketing) can offer cream of honey or honey nut to advantage. The owner of the stand can explain what they are and thus make a sale, provided he will give the purchaser a sample. The "sample" will make the sale every time. The grocer can do the same thing if he will; but usually he has so many other food products that honey is lost sight of. It is often not even on the shelves where it can be seen.

H

HANDLING BEES.—See Manipulation of Colonies; Frames, Self-spacing; Anger of Bees; also Stings, and Hives.

HAULING BEES.—See Moving Bees.

HEARTSEASE (*Polygonum persicaria*).—This is one of the large family of nectar-bearing plants of which the common buckwheat is one. Heartsease, sometimes known as lady's thumb, knotweed, or heartweed, is naturalized from Europe, and is widely distributed over eastern and central North America, particularly in Illinois, Kansas, and Nebraska. In the last-named state it reaches a height of from three to five feet, and grows luxuriantly on all waste and stubble lands. The flowers in oblong clusters are generally reddish purple, or, in rare instances, white. It yields in Nebraska, and other states in that section of the country, immense quantities of honey.

The extracted honey varies in color from a light to a dark amber; and the

flavor, while not quite up to that of white honey, is very good. Heartsease comb honey, in point of color, is almost as white as that of clover. The extracted granulates in very fine crystals, and looks very much like the candied product of any white honey. Care should be taken

Heartsease.

in liquefying, as heartsease honey is injured more easily by overheating than any other honey.

HEAT.—See Artificial Heat.

HERMAPHRODITE BEES.—These are nothing more nor less than freaks of nature—that is to say, one will sometimes see worker bees having drone heads and drones with worker heads. They are not very common, it is true; but about once a year there is sent in to the author specimens of either the one or the other kind of bees that have, apparently, appropriated the wrong head. The beginner needs to be reminded that the head of a drone is very different in appearance from that of a worker or queen. The two compound eyes of the former are large and well developed, while in the latter they are much smaller.

Under the head of Drones, to which the reader is referred, mention is made of another freak of nature—namely, drones with variously colored heads.

HIVE-MAKING.—Unless one is so situated that freights are low, and unless, also, he is a carpenter or natural genius in "making things," he would better let hive-making alone. Hives can be bought usually, with freight added, for much less than the average beekeeper can make them himself, if spoiled lumber, sawed fingers, and the expense of buzz saws are considered; moreover, hives made in the large factories, where they are turned out by the thousands, by special machinery run by skilled workmen, are much more accurately cut. Many of the home-made fixtures will not fit even when made by a carpenter.

The following letter from a practical planing-mill man, who ought to know and does know what he is talking about, sets forth the actual facts as they are:

ELIAS BAMBERGER
Manufacturer of
SASH, DOORS, BLINDS
Contractors' and Builders' Supplies, including
All Kinds of Window Glass
Cor. Exchange and Adams Sts.
Estimates Furnished on Application

Freeport, Ill., June 11, 1907

The A. I. Root Co., Medina, Ohio.

Gentlemen:—I received five of your hives yesterday and find that I can not make my own hives and supplies as cheap as yours and use the same quality of lumber. You can see by the head of this letter that if any one can make hives cheaper than your prices or any of the so-called "trust-hive" manufacturers, I ought to be able to do it; but, using the same quality of lumber, I can not.

JOHN H. BAMBERGER

Again another writes:

West Allis, Wis., August 7, 1926.

I am a patternmaker by trade and no one denies that extreme accuracy is required in that craft. Time is money to all of us engaged extensively in honey production. I can make accurate hives and frames, but at a much greater cost. In home-made goods a uniform standard of accuracy would be difficult to maintain, but in factory-made goods everything is standard.

I have made hives, bottom-boards, covers, and frames, but I long ago reached the conclusion that it was real economy to invest in standard factory-made equipment, and would never dream of making goods that could be bought.

JOSEPH M. BARR.

On account of the diverse notions of beekeepers and the peculiarities of locality, it would hardly be worth while to give general directions for the manufacture of any one hive; and, besides, no printed directions will give as good an idea of the construction of a hive as the

very thing itself. For these and other reasons it would be far better for the one who intends to make hives to send to some manufacturer for a sample in the flat, all complete. With the several pieces for patterns he will then know exactly the shape and dimensions, how to make rabbets, and in general how the hive is constructed in every detail. If one does not find on the market just such a hive as suits his notion, of course he sees, or thinks he sees, "in his mind's eye" something better; but in that case the author would strongly urge him to make a sample or two before he makes very many of them; for ninety-nine times out of one hundred—he will discard the one of his invention, and adopt some standard made by manufacturers generally. If one ever goes out of the bee business he will find his special hives will be hard to sell because they will not fit standard equipment.

A beginner or any one else who imagines he can get up a better hive or frame than those who have spent a lifetime in the business is doomed to disappointment. He will see his mistake after he has had more experience.

HIVE ON SCALES.—See Scale Hive.

HIVES.—The word "hive," broadly speaking, covers any sort of enclosure in which bees make their home. In the primitive days these consisted of hollow logs two or three feet long with a board for the cover and another board for the bottom. Later boxes were constructed. (See Box Hives.) In early times straw skeps were used, and are still used in parts of Europe and southeastern United States. (See Skep.)

The modern hive consists, first, of a brood-body, a box without top or bottom, to hold a series of frames. (See Frames.) Each frame encloses a comb. But no hive is complete without a roof or cover, and a bottom, usually called a bottom-board. In addition to the roof and hive-body, with its frames and bottom, there are upper stories, or supers. A super, just as its name indicates, is an upper story—a box without cover or bottom to hold either a set of frames or a set of holders to support section honey-boxes in which bees store honey. For a further description of hives, see A B C of Beekeeping, page 4. For particulars regarding comb-honey supers, see Comb Honey, Appliances for. For directions to make, see Hive-making. For a description of the hives of early days, and changes leading up to the present, see Hives, Evolution of.

Requisites of a Good Hive

While it is very important to have well-made hives for the bees it should be understood that the hive will not insure a crop of honey. As the veteran Mr. Gallup used to say, "A good swarm of bees will store almost as much honey in a half-barrel or nail-keg as in the most elaborate and expensive hive made, other things being equal." This is based on a good colony in the height of the honey season. Should the bees get their nail-keg full of honey they would have to cease work or swarm, and either way a considerable loss of honey would be the result. The thin walls of the nail-keg would hardly be the best economy for a wintering hive, nor for a summer hive either, unless it were well shaded from the direct rays of the sun.

P. H. Elwood of Starkville, N. Y., who had over 1,000 colonies, said in "Gleanings in Bee Culture" some time ago, "A good hive must fill two requirements reasonably well to be worthy of that name. 1. It must be a good home for the bees. 2. It must in addition be so constructed as to be convenient to perform the various operations required by modern beekeeping. The first of these requirements is filled very well by a good box or straw hive. Bees will store as much honey in these hives as in any, and in the North they will winter and spring as well in a straw hive as in any other. They do not, however, fill the second requirement; and to meet this, the movable-frame hive was invented."

Under A B C of Beekeeping, subhead The Modern Hive, are shown the general features of the hive, and under Hives and also Frames will be shown styles and the special features that belong to each. But there is only one hive that is used largely throughout the United States, and that is the Langstroth—or more exactly, one based on Langstroth dimensions. The frame is 17⅝ long by 9⅛ deep, outside measure. This establishes the length and depth of the hive. As to width, that depends upon the number of frames used. It is the rule to allow $\frac{5}{16}$ bee-space between the ends of the frames and the inside ends of the hive. This will make the

inside length of a Langstroth hive 18¼ inches, or the outside length 20 inches if made of ⅞-inch planed lumber. It is the rule to make the depth of the hive ⅜ inch deeper than the frame—⅛ inch under the frame and ¼ inch on top. For dry climates a greater allowance should be made on account of shrinkage. The selection of the frame, the number to the hive, and the distance they are spaced apart determine the dimensions of the hive itself.

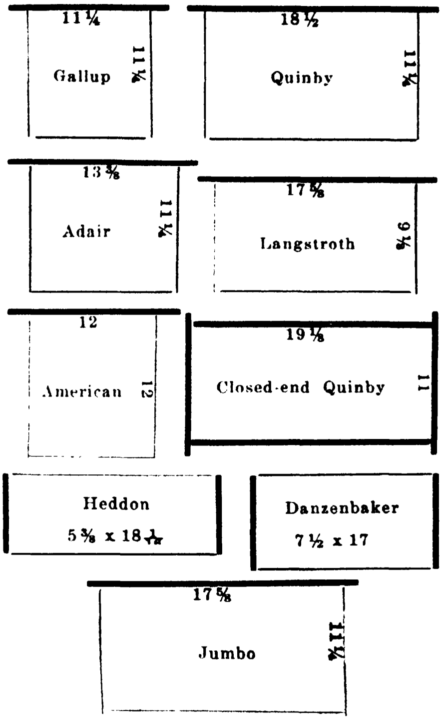
As stated, the Langstroth is the standard throughout the United States; but there has been a tendency on the part of a very few toward a frame of the same length, but two inches deeper. There was also a tendency to go to the other extreme in adopting a frame of Langstroth length, but two or three inches shallower, using two stories of such a hive for a single brood-nest.

Dimensions of Hives

Hives based on Langstroth dimensions are the standard. Some 30 years ago there were in use the American, Gallup, Langstroth, Adair, and Quinby frames. All of these required, of course, hives of different dimensions. Between the Adair, the Gallup, and the American there was but very little difference, comparatively, as they were cubical, and very nearly of a size. The Langstroth was long and shallow—the shallowest frame that had then been introduced; and the Quinby, having about the same proportions, was the largest frame in general use. By consulting the diagram containing the different sizes of frames it will be seen that there are practically two classes — the square and the oblong. As there would be but very little difference, theoretically and practically, between the results secured with a Gallup, American, and Adair, the arguments for the square frames will be considered.

Square Frames

In nature, bees have a tendency to make a brood-nest in the form of a sphere; patches of brood are more inclined to be circular than square or oblong. Theoretically, a circular frame would be the best; but as that would not be practicable, owing to the difficulty in the construction of the frame and hive, obviously the square frame would come the nearest to conforming to nature and a perfect cube for the hive. The square frame, as a rule, calls for a hive in the exact shape of a cube. If, for instance, the frame was 12 inches square, outside dimensions, then the hive, if the combs were spaced 1⅜ inches apart, and 12¾ inches wide inside, should take in just nine American frames. Such a hive, it was argued, would conserve the heat of the bees to the best advantage, would give the greatest cubic contents for a given



amount of lumber—barring, of course, the perfect sphere. As it economized heat in winter, it would winter bees better than a hive having oblong frames.

All of this seemed to be very pretty in theory. G. M. Doolittle, who used the Gallup frames for years, argued for the square frame. A few years before his death he began using the Langstroth frame and hive, and later came to the conclusion that bees wintered just as well in it, and because it was standard recommended it. The great majority of beekeepers, after having tried the square and the oblong frames, finally decided in favor of the Langstroth, as did Doolittle.

At this point the reader should read the article on bee-spaces, found under Bee-space, and also Frames. Both of these articles discuss principles that are vital in the construction of a modern hive.

The Langstroth Frame and Hive and Why It Became the Standard

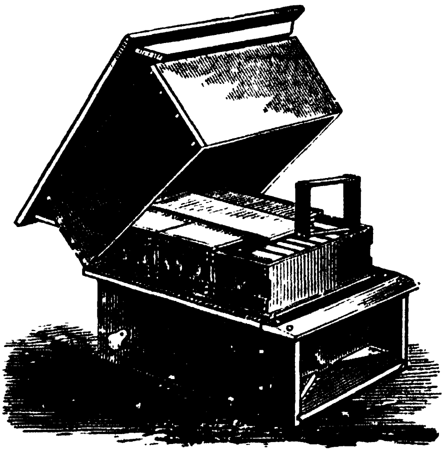
1. A shallow frame permits the use of a low flat hive that can easily be tiered up one, two, three, or ten stories high. This is a great advantage when one is running for extracted honey, as all that is necessary when the bees require more room is to add upper stories as fast as the bees require them, and then at the end of the season extract whenever it is convenient. Square or deep hives can not be tiered up very high without becoming top-heavy and out of convenient reach of the operator. (See page 301.)

2. The long shallow frame is more easily uncapped because the blade of the uncapping knife can reach clear across it.

3. The shape of the Langstroth frame favors an extractor of good proportion.

4. A deep frame is not as easily lifted out of a hive and is more liable to kill bees in the process of removing and inserting frames.

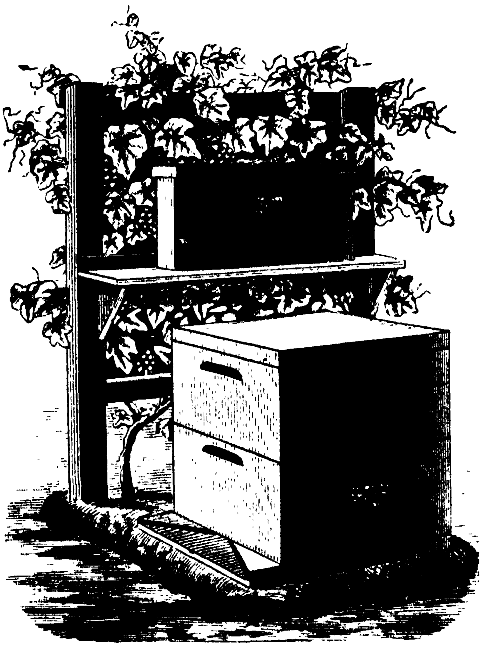
5. The shallow frame is better adapted for section or comb honey. It is well known that bees, after forming a brood-circle, are inclined to put sealed honey just over the brood. In a frame as shallow as the



The original Langstroth hive.

Langstroth there will be less honey in the brood-nest and more in the boxes; for bees, in order to complete their brood-circle in the Langstroth, will, with a prolific queen, often push the brood-line almost up to the top-bar, and, consequently, when honey comes in, will put it into the supers or boxes just where it is wanted.

6. When bees are left to themselves they will generally form a cluster late in the season, immediately over the entrance of the hive, and down two or three inches from the top of the frames. As the season progresses the cluster eats into the stores above it; and on reaching the top it works backward. It therefore hap-



The "Simplicity" hive first manufactured by A. I. Root in the early 70's.

pens that the cluster reaches the top of the hive where it is the warmest during the coldest part of the year. In the case of the ordinary square frame the bees will be found just over the entrance, four or five inches from the top; but in the midst of the coldest weather the bees may not and probably will not be near the top of the hive, as on reaching the top they can progress backward only a comparatively short distance because the top-bar of a square frame is relatively short. In the case of the Langstroth hive, the bees during the entire cold part of winter stay in the top of the hive, where it is the warmest. As the stores are consumed they move backward and gradually reach the back of the hive, and by that time warmer weather will probably prevail.

In actual experience bees seem to winter just as well on a Langstroth as on any other; and, as the shallow frame is better adapted to section honey, beekeepers nat-

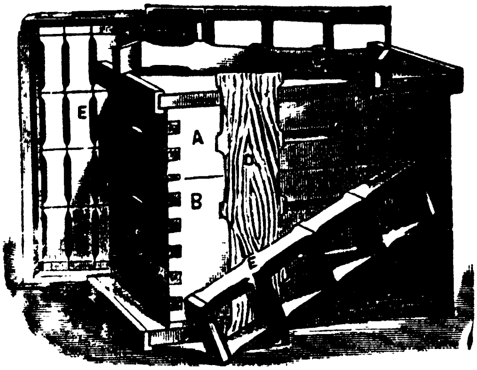
urally turned toward the shallower frame, with the result that now probably 95 per cent of all the frames in the United States are of Langstroth dimensions. Whatever advantage there may be in favor of the square shape, the beekeeper is able to buy standard goods so much cheaper that he adopts the Langstroth frame.

Frames Shallower or Deeper Than the Langstroth

A few years ago there was a tendency toward a frame still shallower than the Langstroth, which resulted in what is called the Heddon; but as eight or ten of these frames, or one super, make too small a brood-nest, two sets of such frames were used to accommodate a whole colony. Of the Heddon hive more will be said further on.

There is another class of beekeepers who feel that the Langstroth is not quite deep enough, and who, therefore, prefer the Quinby. They argue that 10 such frames, or frames Langstroth length and two inches deeper, are none too large for a prolific queen, and that these big colonies swarm less, get more honey, and winter better. Of these, more will be said under the subject of Large vs. Small Hives further on.

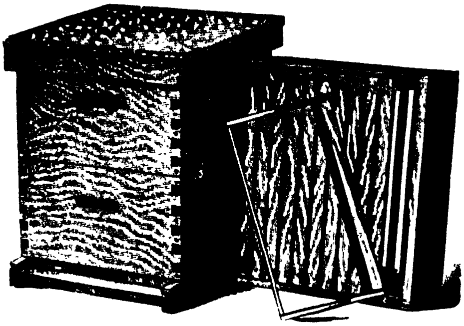
The old original Langstroth hive that the Rev. L. L. Langstroth put out contained 10 frames 17⅜ x 9⅛.* Each hive had a portico, and cleats nailed around the top edge to support a telescoping cover, under which were placed the comb-honey boxes, or big cushions for winter. There was a time when this style of hive was the only one used; but owing to the fact that it was not simple in construction, that the portico was a splendid harboring-place for cobwebs and gave the bees encouragement for clustering out on hot days instead of attending to their work inside of the hives, a far simpler form of hive was devised. The Simplicity, first brought out by A. I. Root, having Langstroth dimensions, was the result. Instead of having telescope covers the contiguous edges of the hive were beveled so as to shed water and give in effect a telescoping cover. The cover and bottom of this hive were exactly alike, the entrance being formed by shoving the hive forward on the bottom, thus making an entrance as wide or narrow as seemed most desirable. But it had one serious defect, and that was the beveled edge. It was found to be practically impossible at times, on account of the bee glue, to separate the upper story from the lower one without breaking or splitting the bevel. Finally there was introduced a hive very much the same, having straight square edges, and along with it came the feature of dovetailing or lock-cornering, as shown.



Original dovetailed hive, Langstroth dimensions.

This hive was introduced in 1889, and seemed to meet with the general approval of beekeepers. It embodied Langstroth dimensions, but used eight instead of ten frames; for, at the time it was introduced, nearly every one preferred eight frames. The original dovetailed hive had a flat cover, and a bottom-board made the same as the cover, except that there were side-cleats to raise the hive off the bottom-board.

Since that time there have been modifications of the hive, and it is now made in eight, ten, and twelve frame sizes.



Two-story hive for extracting.

While the eight was used almost exclusively, the ten-frame size has nearly supplanted it. There is also a tendency to-

*The length for over 65 years has been 17⅝ instead of 17⅜. The change was made to make the length twice the depth to take in four sections 4¼ inches square.

ward the twelve-frame size. (See the Twelve-frame Hive further on in this article.)

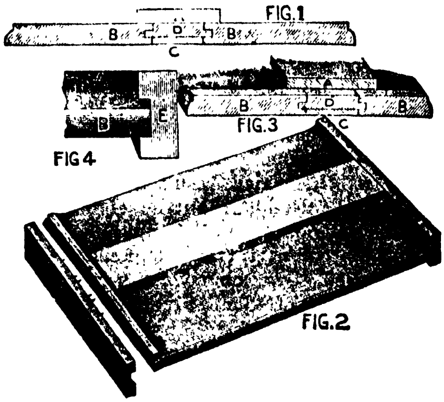
The cover is made single or double. The body is locked at the corners, and the bottom-board is made in several styles. (See Entrances.)

The Hoffman self-spacing frames, described under Frames, Self-spacing, and Frames, to Manipulate, also Frames, are used in the dovetailed hive almost exclusively. The supers for this hive are the same as those shown under Comb Honey.

As now constructed the hive embodies the very latest developments in hives and hive-construction. It can be handled rapidly, and is especially adapted for outapiary work, where frequent moving from one field to another is necessary. It is standard, being made by all the supply-manufacturing concerns, and is for sale everywhere. The lock corner is especially well adapted for hot climates; and for any place it is far superior to corners depending on nails alone. The ordinary miter or halved joint is inclined to pull apart in parts of California, Texas, Florida, and other portions of our country subject to extremes of heat, or hot dry winds.

Flat cover, old style.

A very important requisite of a good hive is a good cover. While the flat cover —one making use of one flat board and two cleats—was a good one, yet, owing to the width of the single board and increasing scarcity of such lumber, something made of two or three narrow boards had to be used. Accordingly, the Excelsior was devised. It consists of boards not exceeding 6 inches in width, because narrow boards can be easily secured, and because they will not shrink and check under the influence of the weather like the wide ones. The two side boards, B, B, are beveled or chamfered on one side so that the one edge is left only about three fourths the thickness of the other edge, but the ends are left full thickness of the boards to shed water away from the edge and to give more nail-room for the grooved end-cleats, E, that slip over and bind the whole together. The purpose of the chamfering is to shed water to the sides of the hive and away from the centerpiece, AD. Of this centerpiece, AD, the part D projects beyond A. It is



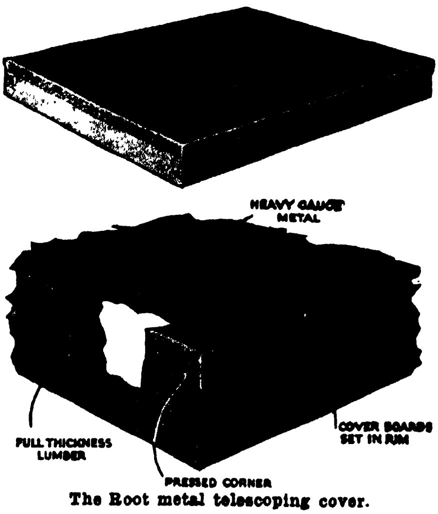
Excelsior flat cover.

tongued on each edge to fit a corresponding groove in the edges of each of the two side boards that were beveled to shed water. The space under D is filled with a thin board ¼ inch thick, the ends of which project into the ⅞-inch groove of the end-cleats, E, where it is securely held in place.

Telescope Covers

In later years the telescope cover with a metal roof and an inner cover, while more expensive, is so much better that it has supplanted nearly all other hive covers.

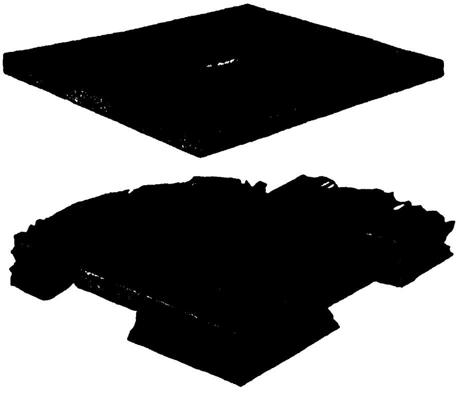
There is a strong and rapidly growing



The Root metal telescoping cover.

tendency at the present time toward a double or telescopic cover, shown in the illustrations.

The lower cover consists of two or more tongued-and-grooved boards, ⅜ inch thick, with rabbeted rim of ¾ x ⅝" wood around the edge. At the center there is a hole for a Porter bee-escape, so that by inserting the escape the inner cover



Detail of inner cover construction.

can be used as an escape-board. The inner cover takes the place of the metal-bound super-cover formerly used. It lies directly over the frames, and over this is placed a shallow telescoping cover made of ⅜ lumber, and covered with sheet metal or roofing paper.

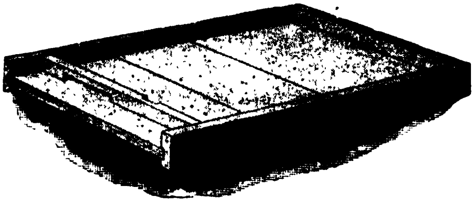
A top protection of this sort is not only better than a single-board cover, but it shuts out the weather. The air-space between the two covers gives the bees better protection from the direct rays of the hot sun if the hives are out in the open; and, if kept painted, such a cover will last indefinitely. The lower cover will be sealed down by the bees. The upper one can not blow off because the downward-projecting sides hold it in place. Of course such an arrangement makes extra handling in opening and closing the hive; but the majority of beekeepers are beginning to see that this is more than offset by the greater durability and better protection.

Hive-bodies or Brood-nests

These are plain boxes without top or bottom, preferably lock-cornered. They are rabbeted at the upper inside ends to receive the projections of the frames referred to later on. Under the head of Frames and A B C of Beekeeping there will be found a diagram showing the position of the hive-body or brood-nest, and how the frames to hold the combs hang in the rabbets before mentioned. Practically all of the hives sent out by the regular beehive factories are lock-cornered for additional strength. When made in local planing-mills the corners are usually "halved" by cutting out a rabbet in the sides or ends; but the lock-cornering is much preferable for the reason stated.

Hive Bottoms, or Floors

The general practice is to make the bottom or floor of the hive separate from the hive-body. Bodies are made to rest upon the raised edges of the floor or bottom. This floor should preferably have a deep side and a shallow side. During hot weather it is customary to use the deep side to give more space under the hive, affording a larger entrance and better ventilation. This deeper side is usually ⅞ inch in depth; the shallower side, only ⅜ inch, is used by those who prefer to have a shallower space under the hive. When the wide space is used it is customary to have a contracting entrance-cleat. When colder weather comes on, or where



Bottom-board.

the colony is weak, it is good practice to contract the entrance to ¼ inch by any width from ½ to 8 inches. (See Entrances.)

There are different styles of floor-boards or bottoms; but the kind used by those who have factory-made hives is like that shown in the illustration.

Brood-frames

The modern hive consists not only of the parts already mentioned — cover, body, and bottom—but a series of frames, each of which holds a comb. In a modern hive the top of the frame has projections at each end that hang in the rabbets of the hive-body. Each of the frames is removable, and may or may not be self-spacing. Some frames have the same width all around. Some have the end-bars made a little wider near the top, and some have end-bars that make con-

tact with the adjacent end-bars their entire length. The latter are called "closed-end" frames.

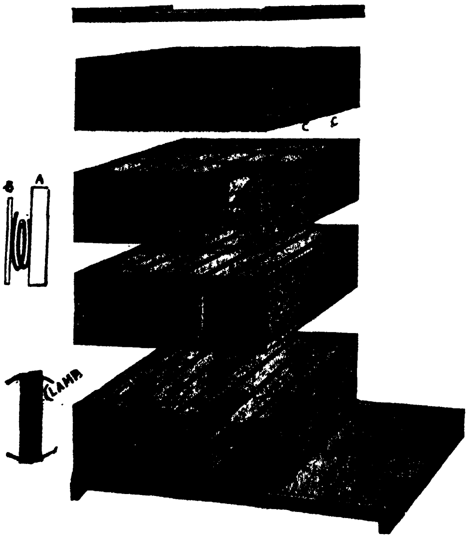
For particulars regarding frames the reader is referred to the A B C of Bee-keeping at the beginning of this work, Frames, and Frames, Self-spacing.

Closed-end Frames

Closed-end frames may be divided into two classes—the standing and suspended. The Quinby, already spoken of under Frames, Self-spacing, the Bingham, and the Heddon are of the first-mentioned class; the Danzenbaker belongs to the latter class. It has been claimed that frames with closed uprights, while perhaps not so convenient for general manipulation, are better adapted to wintering. Frames with partly closed ends, like the Hoffman, are open part way up, and like the unspaced hanging frame, permit of currents of air around the ends of the frames, and (it is claimed), as a consequence, bees are not so much inclined to bring their brood clear out to the end-bars as they do when closed ends are used. The difference is more theoretical than real.

The Bingham Hive

Mr. Quinby was the first to apply Huber's principle of closed-end frames in



The Bingham hive.

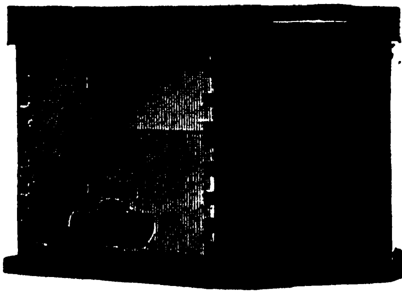
this country (see Hives, Evolution of). This he introduced shortly after the appearance of the Langstroth hive. Not long after, in 1867, Mr. Bingham brought out his hive with closed-end frames with a narrow top-bar and no bottom-bar, but still embodying the chief features of Huber's hive of 1789. But the peculiar feature of the Bingham was that it made use of shallow frames only five inches deep, a series of them being lashed together by means of a wire loop and stretcher sticks, the loop drawing on the follower-boards in such a way as to bring tight compression on frames enclosed. Seven of these brood-frames in the hive made up a brood-nest, and an entire brood-nest might consist of one or two sets of frames. The top-bar was dropped down from the top of the end-bars a bee-space, while the bottom-bars were flush with the bottoms of the end-bars. With a bottom-board having a ⅜-inch strip on each side, the ordinary bee-space is preserved through the several divisions of the hive.

The super is like any ordinary one adapted to comb honey, except that it uses coiled springs to produce the necessary tension.

Although Mr. Bingham used this hive for a great many years, and quite successfully too, no one else seems to have done much with it; but a modification of the hive is shown in the Danzenbaker and the Heddon.

The Danzenbaker Hive

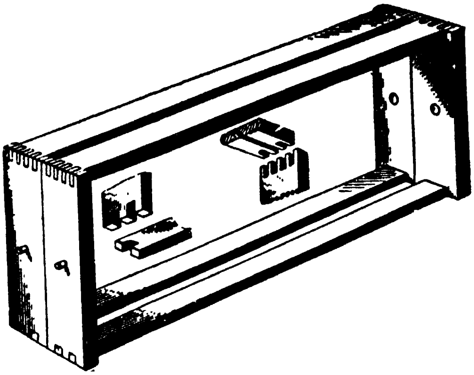
The Danzenbaker consists of a brood-chamber of the same length and width as the ten-frame Langstroth dovetailed hive, but deep enough to take in a depth of frame of only 7½ inches. The rabbet, instead of being near the upper edge, is dropped down about midway; or, more strictly speaking, there is a cleat or board



The Danzenbaker hive.

nailed on the inside of the ends of the hive. On this support hang the closed-end brood-frames, pivoted at the center of the end-bars by means of a rivet driven through from the inside, as shown on next page. Ten of these frames fill

the hive. As these frames are pivoted in the center, they can be reversed; and this feature, while it costs nothing, is something to be desired, as it enables one to have all frames filled solid with comb.



Frames can be reversed by means of the pivot in the center.

The bottom of the hive is the same as that for the dovetailed hive, already described. The super for comb honey takes the 4 x 5 plain section, using the fence-separator system. The sections are supported in section-holders. The whole arrangement is the same as the section-holder super already described in Comb Honey, Appliances for.

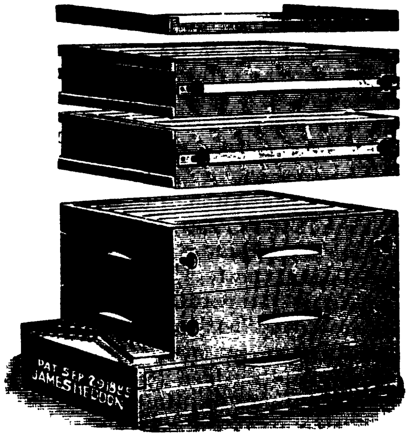
This hive was designed primarily for the production of comb honey. As a comb-honey hive it is a very good one; but on account of handling the brood-frames it has become so unpopular that it has almost gone out of use. Any hive with Hoffman or with the unspaced frames will, in a given time, permit the examination of three or four times the comb surface of the closed-end frames unless a single exception be made of the closed-end Quinby, illustrated and described under the head of Frames, Self-spacing.

Where bee glue (propolis) is very abundant the closed-end frames become so badly gummed up that it is almost impossible to separate them at times. For that reason the foulbrood bee inspectors generally advise against Danzenbaker frames.

The same general criticisms would apply with equal force against the Heddon hive next described, which likewise, and for the same reasons, has all but gone out of use.

The Heddon Hive

This hive was patented and introduced in 1885. Its peculiar and distinguishing feature was in the use of one brood-chamber divided into halves horizontally, each half containing a set of eight closed-end close-fitting brood-frames, 5⅜ inches deep by 18⅛. The end-bars, as already stated, were close-fitting — that is, the brood-frame slid into the hive with just enough play to allow of its easy removal and insertion. On the bottom inside edge of the ends of each case were nailed strips of tin to support the frames, and the whole set of eight was squeezed firmly together by means of wooden thumb-screws as shown. Under the head of Comb Honey mention is made of the value of compression for squeezing sections or section-holders or wide frames. The more tightly the parts are held together, the less chance there is for bees to chink propolis into the cracks.



The Heddon Hive.

The bottom-board of this hive was much like that used on the Standard hives, in that it had a raised rim on the two sides and end to support the brood-chamber. The cover was the ordinary flat one-board, cleated at the ends.

The purpose of the inventor in having the hive divided in this way was to afford more rapid handling, and to accomplish contraction by taking from the brood part of the hive one or more sections. This divisible feature of the hive, according to its inventor, enabled him to handle *hives* instead of *frames*, to find the queen by shaking the bees out of one or both of the shallow sections. The horizontal bee-space through the center of the brood-nest he considered an advantage in wintering, because the bees could move up and down and laterally between the combs.

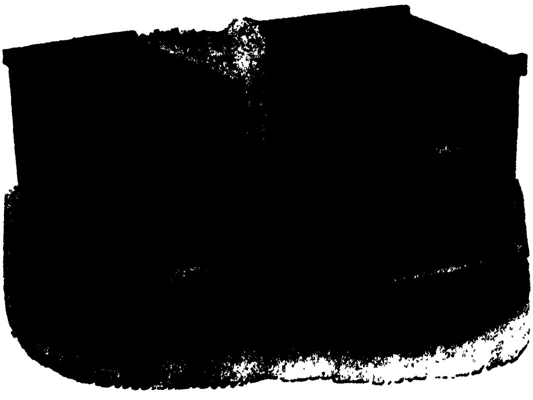
This hive, as was explained at the close of the article on Contraction, was responsible in a large measure for the failure of the crops of those who used it. The principle of small hives and excessive contraction has been shown to be a monumental blunder that nearly ruined beekeeping in the 90's. (See Contraction, and Mistakes in Beekeeping.)

The Dadant Hive

Almost the very opposite of the Heddon in principle and general construction is the Dadant hive. While Mr. Heddon divided the brood-chamber into one, two, or three separate portions, Charles Dadant had it all in one large complete whole. The frames were 18⅛ x 11¼—the Quinby dimensions. There are ten to the hive. Such a hive has about the equivalent capacity of a twelve-frame Langstroth, regular depth. Mr. Dadant held that their ten-frame Quinbys, when compared with the ten-frame Langstroth, averaged up year after year, would give far better results, both in honey and in economy of labor.

The Ten-frame Hive of Extra Depth

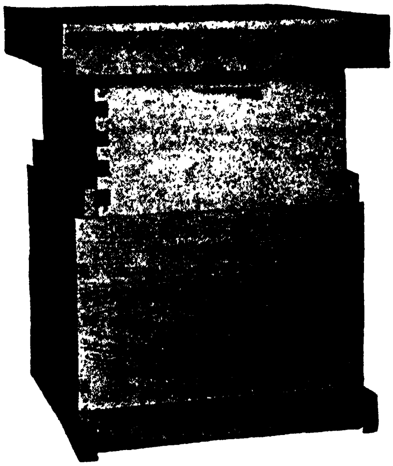
It was suggested by A. N. Draper, formerly of Upper Alton, Ill., one of Mr. Dadant's followers, that, instead of making a hive after Quinby's dimensions and on the Dadant pattern, a hive be constructed after the pattern of the regular ten-frame dovetailed, having Langstroth dimensions save in one measurement—that of depth. He added to the hive and frame 2⅛ inches. As Mr. Dadant used nine frames in his original Quinby hives, ten frames 2⅛ inches deeper, with Langstroth top-bar, would give the hive equal capacity. Such a hive would take regular Langstroth ten-frame bottom-boards, covers, supers, honey-boards, winter-cases—in fact, everything adapted to the regular ten-frame Langstroth dovetailed hive. As the ten-frame hive is one of the standards, if the large hive is really better such a hive would be more simple and cost less than to adopt regular Quinby-frame dimensions. The supply-dealer will make the brood-chamber for about 25 per cent more than the regular ten-frame Langstroth dovetailed; the supers, covers, bottoms-boards would cost no more.



The comparative difference in size between a regular ten-frame hive and a ten-frame Jumbo.

The Modified-Dadant Hive

In 1917 Dadant & Sons brought out something similar to the one just describ-



The modified Dadant hive with a regular ten-frame Langstroth upper story. As the latter is narrower it is necessary to close up the space with a couple of cleats.

ed, except that it was 11 frames wide, 1½-inch spacing, Langstroth length, and Quinby depth. The extra frame makes it a little too wide to use supers and hive-bodies of standard dimensions without cleats to close up the space as shown. This hive requires a special bottom-board and a special cover.

This hive is very popular in some sections of the country. The principal objection to it is, that as a single unit it is too heavy for one person to lift when full of bees, brood and honey.

The Twelve-frame Langstroth Hive

There are some others besides the Dadants who believe that the ordinary ten-frame Langstroth hive-body makes too small a brood-chamber; that a good queen, such as ought to be in every hive of every honey producer will easily fill a twelve-frame hive with brood.

The Thirteen-frame Langstroth Hive

There are a few who use a thirteen-frame Langstroth hive which is practically the same as the twelve-frame hive that has been in use so long. The advantage claimed is that the hive is larger and exactly square. This makes it possible to reverse the position of frames with reference to the entrance, during summer or winter, by merely turning the hive around one quarter-turn on the bottom. During the winter it is an advantage to have the *sides* of the frames exposed to the entrance. During the summer it is certainly better to have the *ends* of the frames next to the entrance, because then the air can blow in clear through the hive, cooling it in hot weather.

(See Extracting, subhead, What Hives to Use for Extracting.)

Two-story Ten-frame or Eight-frame Langstroth Hives

Where the eight or ten frame hive is used, it is customary to have the colony breed in two stories. As already explained, the average queen will go beyond ten frames. If she or the bees are not given unlimited room for breeding, cells may be started and a swarm may follow. To prevent this it is usually customary to put on another hive-body, or upper story containing combs.

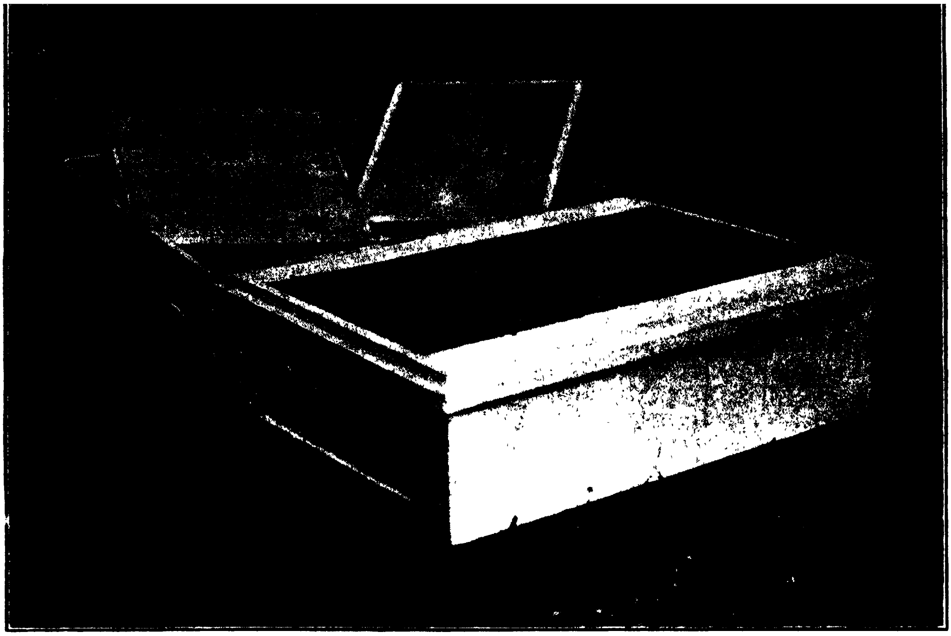
Ninety-five per cent of the honey-producers of the country are using hives of Langstroth dimensions. It is possible for the expert beekeeper or the novice, if he will study directions carefully, to manipulate his brood-chambers of Langstroth dimensions so that he can not only secure the maximum amount of brood and bees of the right age for the harvest, but he will be able to keep down swarming for the production of extracted or comb honey. For particulars regarding this, see Swarm-control, under Swarming, Demaree Plan of Swarm-control; Why Standard Equipment, under Extracting, and Food-chamber, especially the last title.

Long-idea Hives

Something over 50 years ago the long-idea hives—that is, 30 and 35 frame hives all in one brood-nest—were advocated by various beekeepers in the United States. Many at that time were very enthusiastic in praise of this hive; but when comb foundation and the one-pound section honey-box came to the front these hives were dropped by nearly every one because they were not adapted to the production of comb honey. In later years, especially during and following the period of the World War, extracted honey was produced almost exclusively. During this time attention was again directed to the Dadant-Quinby hive, the ten-frame Jumbo, practically the same thing, and the twelve and thirteen frame hives.

While some were favoring the larger hives of the styles mentioned, there were a few who were going back to the old long-idea hive containing all the way from 25 to 35 frames. The dimensions of these hives would be more like those of a coffin or a trunk. The advocates of these hives, particularly O. O. Poppleton, of Florida, who had always used them, claimed that they were large enough so that no tiering-up was required—no lifting on or off of upper stories, no manipulation of brood-combs from the lower to the upper story to hold back swarming—in short, nothing heavier to lift than a single brood-frame. They also claimed almost entire immunity from swarming.

The usual practice with such a long hive is to have the entrance on the side, the long way, and place the brood-nest in the center of the hive. This leaves room for ten or twelve frames capacity for more brood on either side. Mr. Poppleton argued that a queen would move sidewise from one brood-frame to another more readily than from one brood-frame in the lower hive body to a brood frame in the hive above, and he was undoubtedly right. The argument was briefly this: That the average Langstroth frame will have a circle of brood running within about two inches of the top-bar. The general reason for this is that the comb will stretch near the top, making neither worker nor drone comb. The queen avoids this, and the bees fill it with honey. In a hive of two stories the queen is apparently slow about getting over this two inches of honey, a ⅞ inch top-bar, a ⅜-inch bee-space, a ¼-inch bottom-bar, and another bee-space before she reaches the comb in the upper hive. Advocates of the long-idea hive claim that the queen can move from comb to comb on a horizontal line, because the brood surfaces are within ⅜ inch apart, the space between being filled with bees. When the queen expands the brood-chamber in the natural way she moves from comb to comb. If the worker-cells are not stretched, and there are no obstructions, she will



Long-idea hive holding twenty-five Langstroth frames. Two regular 10-frame supers may be placed side by side on this hive, as it is two and a half times the size of a regular 10-frame hive.

move vertically as well as horizontally; but in the modern tiered-up hive she may not move upward unless the brood is carried upstairs by the apiarist himself. It is for this reason that the old long-idea hive has been revived.

Another advantage claimed for the long single-story hive is that it is adapted to the use of old men, and women, young and old, or any one else who, for physical reasons, can not lift the weight of a filled super (40 or 50 pounds), but who can handle individual units of one comb at a time.

Finally it is argued that during winter or cool weather the brood-nests can be confined to about twelve or fifteen frames, and the space on either end filled with packing material. If the cover of the long-idea hive is three or four inches deep, and telescoping, additional packing can be put on top. The hive is, therefore, adapted for wintering as well as for summering bees.

The hive is especially adapted to the use of beginners who either will not learn how to handle swarms in standard hives or have no time to do so. A colony in such a large brood-chamber that can expand laterally will require less attention than any other hive here shown. However, in localities where brood diseases are prevalent, neither this hive nor any other should be left to itself without frequent examination.

Caution

It should be understood, also, that the same objections that apply to especially large brood-chambers apply to this one. As a general rule, the ordinary beekeeper would do well to have everything standard. The Langstroth ten-frame hives described in these pages are more standard than any other hive in the United States if not in the whole world. None of these big hives are adapted to the production of comb honey in sections, and none of their advocates make any claims for them along this line. There are times when comb honey brings such good prices that it is advantageous to change from the production of extracted honey to honey in sections and this is entirely practicable with the standard hives.

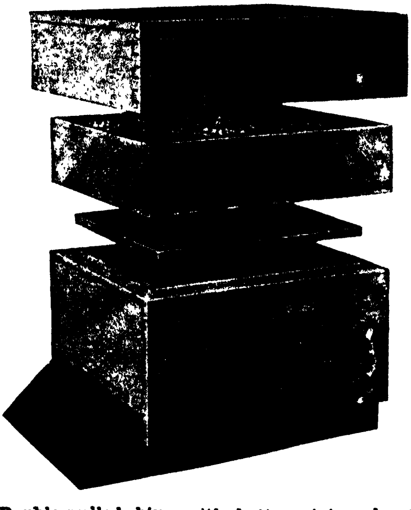
Last, but not least, if one wishes to sell his apiary at any time he can get the best price for it if it is made up of standard Langstroth hives.

The author does not advocate the adoption of any of these special hives. If one

is interested, let him experiment with half a dozen or a dozen hives. If the tests of the few are satisfactory he can use more. It is usually a safe policy, especially if one is a beginner, to follow in the beaten paths, or, more exactly, use standard ten-frame Langstroth hives and equipment. As a rule, bees will sell at a h gher price in these hives than when they are in something that is odd-sized or irregular. Moreover, the average dealer or beehive manufacturer always has the standard equipment in stock. While the regular Langstroth may require extra manipulation and extra lifting these "extras" make more brood and bees. It would be wise to use these hives until the general public has proved that what some may call "freaks" are better than the standards.

Double-walled or Packed Hives

The hives thus far described and illustrated are what may be called single-walled hives; that is, the outer shell or



Double-walled hive with bottom integral with the hive.

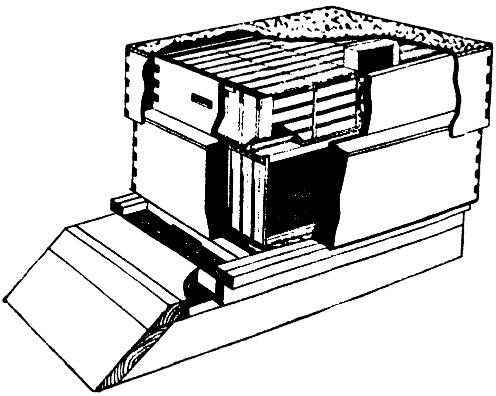
case consists of a single thickness of lumber. Such hives in the northern climates, as a rule, can not very well be wintered outdoors on their summer stands. They must either be carried into the cellar at the approach of cold weather, or else put into outside packing-cases, as the single walls hardly afford sufficient protection to enable the average colony to go through the winter safely, or without great loss both in bees and in stores.

In the South, of course, it is not necessary to carry the single-walled hives into the cellar or winter repository; but north of latitude 40, hives of single-board thickness ought to be either housed or protected with winter cases. Where one from choice or necessity has to winter outdoors, what are known as double-walled hives should be used. These have the same inside dimensions as the single-walled hive, and are generally made to take the same supers and the same inside furniture. The one shown in the illustration on this page represents a ten-frame Langstroth single-story double-walled hive; and as it represents the simplest form of hive for wintering, we will describe this only, leaving the reader to adapt it to the dimensions of whatever frame he is using.

The space between the walls is filled with some porous material like dry leaves, planer shavings, cut straw or hay, ground cork, or any material that is light, loose, and porous. An examination of the illustrations on this page and page 389 will show how this warm ideal hive differs from the others.

Bees are essentially warm-blooded animals, and if they are not warmly housed in our northern climates they will die during winter.

Careful observations have shown that these double-walled packed hives will



Buckeye double-walled hive with space between the walls filled with packing material.

yield larger returns in honey. It is a well-known fact that in the domestic economy of a hive comb-building can not progress unless a temperature of 95 degrees is maintained. Frequently in good honey-gathering weather the nights are cold enough so that the inside of the hive

will be chilled and comb-building will stop; for the bees are compelled to leave that work to hover around their brood to keep it warm. In the double-walled packed hive brood-rearing and comb-building can continue, during ordinary summer weather, no matter what the temperature may be outside.

But this is not all. While bees in single-walled hives often do come through the winter successfully, the result is attained at a considerable loss in stores. Overfeeding on the part of the bees, in order to keep up the temperature of the cluster, causes overloading of the intestines, and this sooner or later brings on the fatal disease known as dysentery. (See Dysentery.) Nothing will use up a colony's vitality in the spring more than this. On the other hand, bees in double-walled packed hives with a food-chamber on top (see Food-chamber), unless the winter is severe, will rarely have it. They come through stronger, cleaner, and better with a larger stock of stores in reserve to take care of the necessary brood-rearing that takes place as soon as warm weather opens.

The reason for this is plain: Experiments show that the internal temperature of a single-walled hive outdoors during winter is only slightly higher than that outside. On the other hand, the internal temperature of a double-walled packed hive is at least 25 to 50 degrees higher than the outside temperature. (See Gleanings in Bee Culture, page 78, for 1912.) The colder the atmosphere in which the bees are kept, the more they have to eat. Overfeeding plus cold causes dysentery.

Taking everything into consideration, if the double-walled hives cost more than the single-walled, they will save from 10 to 25 per cent of the stores and at least 25 to 50 per cent of the winter losses, year in and year out. During spring and summer a larger return in honey may be expected for the reason that the bees are not obliged to stop their comb-building because their super is too cold nor stop brood-rearing in the spring. Neither are they forced to eat too much of the freshly gathered stores in order to keep up bodily heat.

Under Wintering Outdoors will be found a mention of the quadruple winter cases. They are so expensive and unwieldly that they are nearly out of use. It would be cheaper to buy package bees from the South than to go to so much expense in packing.

The double-walled hive has the advantage that it is more suitable for the back-lot beekeeper, the farmer beekeeper, those who desire to leave their bees on the same stand the year around, and who, on account of other duties, can not fuss with putting bees in the cellar and taking them out again, or packing and unpacking in large winter cases.

Construction of the Buckeye Hive

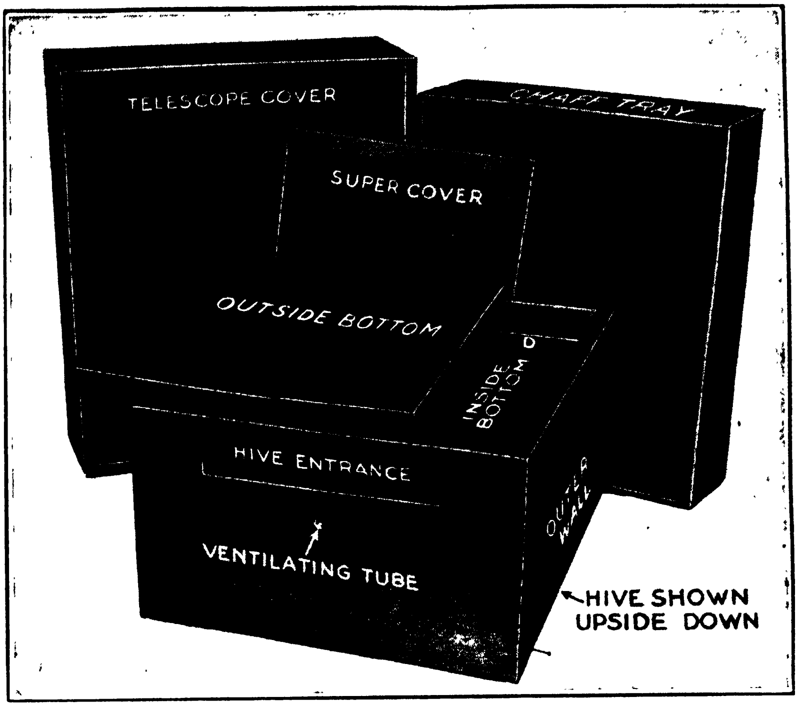
The brood-chamber is made of an outer wall of ⅞-inch and an inner wall of ⅜-inch lumber, lock-cornered for strength. The space between the two walls is covered over with a sort of picture-frame water-table. This is secured to the inner chamber, as shown next page, then nailed to the inner and outer wall. The unfinished hive is turned upside down before the bottom cleats are nailed in and the double wall filled with packing material.

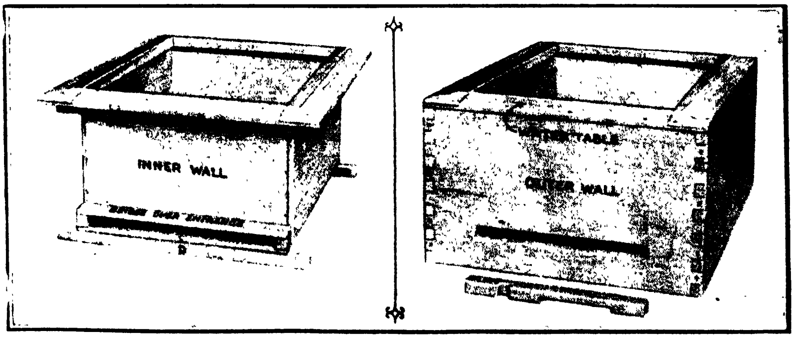
Experience shows that the top needs protection more than the sides. Hence there is a tray made of ⅜-inch lumber with a bottom of common burlap, which is left in a baggy condition so that the tray will fit tightly to the hive, thus preventing the wind from whistling in under the tray. The inner cover is put in place after the frames and the bees are in the hive, then the tray is put on top of the whole. This is filled level full of packing material, such as leaves or planer shavings, and over this is then placed the large cap or cover that goes over the table.

It will thus be observed that this double hive is made on the plan of an ordinary refrigerator, or like a safe cabinet built to protect its contents from fire. Anything that will keep ice from melting will in like manner keep water from freezing. The principle is the same as that of the well-known thermos bottle. The thermos bottle will keep water cold or hot for hours and hours. The double-walled hive next shown will keep a cake of ice, if the entrance is closed, almost as well as a refrigerator. It will also hold a pail of boiling water and keep it hot for hours on the principle of a fireless cooker.

The general features that go to make up a refrigerator or a fireless cooker apply equally well to a beehive.

Some have the notion that a hive having



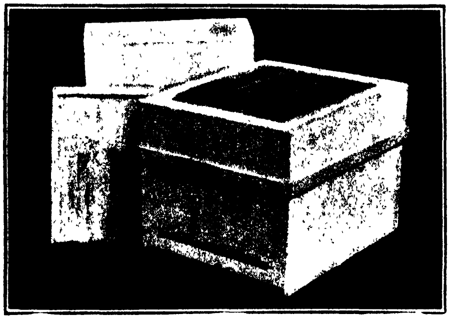


This hive consists of a double-walled hive-body and a packed bottom in one unit, a super, cover, a tray with burlap bottom in which packing material is to be placed, and the telescoping metal roofed cover.

a so-called dead-air space will winter bees as well as one having space filled with packing material. This is a mistake. In the first place, there is no such thing as "dead air" space in a beehive or in anything else. Air is bound to circulate. The air next to the cold outer wall is cooled, and necessarily circulates over to the other side or inner side where it is warm. The cold air rushing over to the warm side cools the warm side, thus making the inner wall almost as cold as the outer. When a hive is so designed that it can hold packing material, this material holds an infinite number of pockets of air in little compartments. As the air in these compartments can not circulate, it follows that the outer wall may be comparatively cold, while the inner one will be warm. The fact that all refrigerators have the space between the walls packed with material goes to show

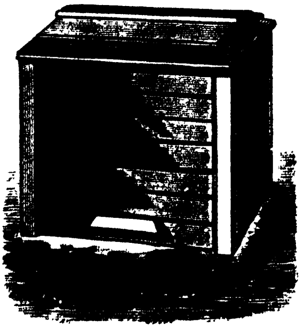
that the theory of "dead air" space between two walls is wrong. Not only that, but actual practice shows a big difference between the so-called double-walled dead-air-space hive and a real double-walled hive, the spaces between which are packed.

At one time it was believed that a double-walled hive did not need a double packed bottom because it was next to the ground, which would be warm. Accordingly, double-walled hives were built



Buckeye hive showing food-chamber inside of packed rim.

with a detachable single-thickness bottom. It was thought that the detachable feature, from the standpoint of cleaning the bottom and tiering up one packed body on another, would more than make up for the slight gain in warmth. But practical tests year after year showed that this was a mistake. Frozen ground with only a single thickness of wood between it and the bees is too much of a



Original Root chaff hive with integral packed bottom.

handicap to good wintering. Government tests showed that a double-walled bottom would radiate far less heat than a bottom of single-thickness wood. (See Circular No. 222, Department of Agriculture.) It was shown likewise that the bottom needed just as much protection as the sides.

A. I. Root, who was the early advocate and pioneer in the use of double-walled hives, had the bottoms of the first hives he made packed and integral with the hive itself. The early editions of this work from 1883 on to the close of the century showed how well he succeeded and that he was right in making the whole hive—top, sides, and bottom—*all double walled and packed.* His original hive, which was two-story, is here shown.

A Double-walled Packed Rim for Food-chamber

By turning to Food-chamber, it will be noted that this is one of the very important essentials for good wintering. The colony may be ever so well packed and of sufficient strength, but it may dwindle to a weak nucleus or die outright before spring if it does not have an ample supply of good sealed stores. Experience shows that good honey for the winter and spring is preferable to sugar syrup fed late. (See Feeding.) The food-chamber given in early fall is the simplest and cheapest way to give this food. (See Food-chamber.) As the bees will work up into it during the winter it is just as important that it should be protected as the rest of the hive. The easiest way to do this is to slip over the super containing the store a double-packed rim. On top of the food-chamber and the packed rim should be placed the inner cover, the tray containing the packing material, and, last of all, the deep cover that telescopes over the whole. When a good colony is so packed and supplied with natural stores the chances are that it will not only winter well but secure a crop of honey the next season, provided there is any honey in the fields.

Entrances for Double-walled Hives

During the summer or during the honey flow the entrance should be as large as those for the single-walled hives—⅞ inch deep by the width of the hive. (See Entrances.) During winter or cold weather it should be contracted to a slot ¼ by two or three inches or the smallest size found in the entrance cleat, depending on the size of the colony. (See Entrances, subhead, Size of Winter Entrances, page 245.)

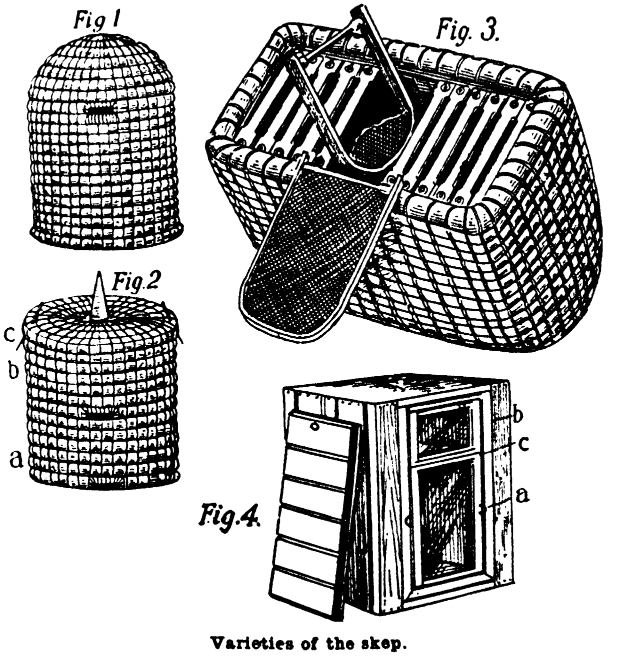
Packing Material

In former times, when chaff from wheat or oats was available, this was the material used. In later years planer shavings have been used very extensively with excellent results. Forest leaves when packed solid are perhaps better yet if dry.

HIVES, EVOLUTION OF.—Primitive hives were simply the trunks of hollow trees in which bees were lodged, cut down and carried wherever the beekeeper desired. The plan of keeping bees in sections of hollow logs, covered with boards or slabs, is still practiced in some parts of Europe and in southeastern United States and is common enough in Africa. The stingless-bee apiaries of South America have hives of this description. (See Skeps.)

The next step was to construct a cylinder resembling the trunk of a tree, either of wood or earthenware. In northern climates straw came into use, but had to be fashioned in the shape of a bell to make it easy of construction. This is the kind of hive which was so highly praised by poets. It has the merit of extreme simplicity and cheapness. Usually it had cross sticks added inside to keep the combs from falling down. (See Skeps.)

Not all beekeepers were satisfied with these hives. As early as the 17th century some few began to cast about for something better. Della Rocca, who wrote a book on bees in the 18th century, mention bar hives as in vogue in the islands of the Grecian Archipelago, where he lived for many years. Bar hives and movable combs are referred to in a book published in Italian in 1590. The author was Giovanni Rucellai. Such hives were known even to the ancient Greeks. They resembled large flowerpots with wooden bars on which the bees were to fasten their combs. The shape of the hive made it practically impossible to cause a breakdown of the combs except by heat.



Varieties of the skep.

The plan of a movable roof was another opportunity to put on an upper story or a super to hold the surplus honey where it should be, and remove it at the end of the honey harvest.

Mewe, in Great Britain, constructed hives of wood on somewhat the same plan as early as 1652, and these were gradually improved by various inventors.

Maraldi, about the same era as Mewe, invented a single-comb observation hive made with glass slides, which contained the germ of the movable comb frame. He allowed too much space for one comb, and frequently the bees built their combs crosswise. Still there was in the Maraldi

hive the important advantage of handling one comb at a time, and by this means to get a far better conception of what was going on inside the hive. Huber extended this idea by his improvement.

To Huber belongs the credit of inventing hives with movable frames,* and it was by using these that he was able to make the discoveries in apiculture which so astonished and delighted the scientific world. Huber invented these hives about 1789, or perhaps a little earlier. It has been contended by some writers that Huber's hive was not practical; but some of the most practical beekeepers the world has yet produced used modified Huber hives, notably Quinby and Hetherington, beekeepers of New York State, whose names are revered by American beekeepers.

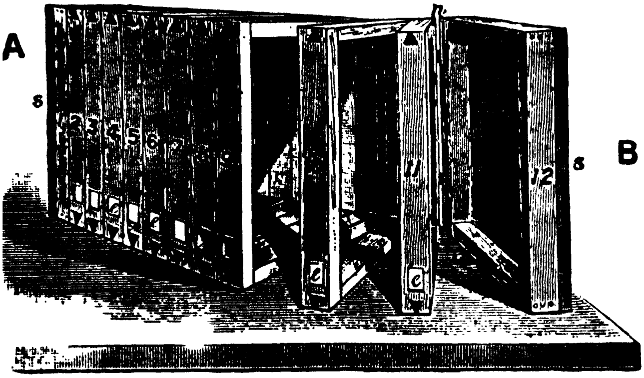


Fig. 1.—Huber's leaf hive.—From Cheshire.

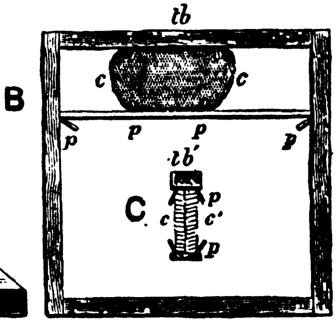


Fig. 2.

An examination of the illustrations of Huber's hive makes it plain that he had a clear idea of what was required in a hive for practical purposes. Fig. 3 shows how he increased his apiary by artificial means. In this case he divided a strong colony by slipping a board between the frames, thereby splitting it in two. His plan of providing a part of each frame for surplus honey (Fig. 2) is excellent. Thus it is evident that Huber invented some of the principal features of our movable-comb hives. The Quinby, Heddon, and Bingham hives are on the movable-comb plan. (See Hives.)

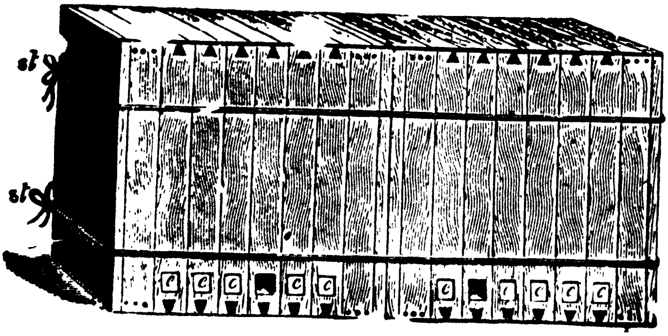


Fig. 3.—Huber hive, showing how he artificially increased the number of his colonies. E, E, E are entrance holes.—From Cheshire.

About 1819 Robert Kerr, of Stewarton, Scotland, invented a bar hive shown in Fig. 4. This hive was used very successfully, and is still in use, but with movable frames instead of mere bars. It was still further improved by Howatson, also of Scotland, about 1825. Here we have the tiering principle clearly shown; and had this author and inventor grasped

*This honor is usually ascribed to Langstroth, for, indeed, he was the first one to invent an all around practical hive and frame—a frame that provided a bee-space all around it; but he did not invent the first movable frame. (See Frames.)

the idea of movable-comb frames instead of bars he would have invented a hive on the Heddon principle.

Prokopovitsch, a Russian, about 1830, invented and made in large numbers a movable-comb hive. (See Fig. 5.) In his own apiaries, of which he had many, were over 3000 of these hives in actual use. His pupils (for he established a school of beekeeping) had many more in use.

It may be noted that his surplus frames bear considerable resemblance to our beeway sections, and that his hives were dovetailed. Prokopovitsch was certainly a beekeeper of remarkable abilities. He employed means and methods far ahead of his time.

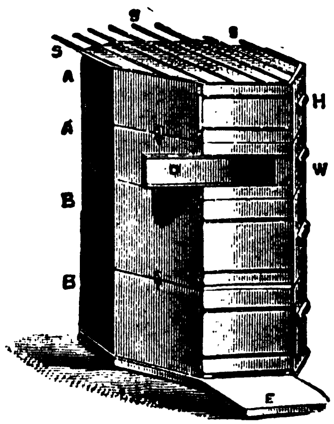


Fig. 4.—The Stewarton hive, 1819; shallow-bar hive with glass strips between bars.—From Cheshire.

It has been claimed by some writers that Dzierzon of Germany, invented movable frames in 1845; but it is evident he has no claim whatever to this distinction. As a matter of fact, according to his own statements, he used bars until 1855, when he was persuaded by Baron Berlepsch to use movable frames, which had just been introduced from America. (See Dzierzon Theory.) Dzierzon's bar combs were removed by using a long knife to cut the attachments from the back of the hive one by one; for, to reach the comb at the front of the hive, all the other combs had first to be removed. His hive was far inferior to those already mentioned. When he adopted frames he did not change the construction of his hives in the least.

Next came Langstroth with his epoch-making movable-comb hive with movable roof, which combined the essential requirements of a hive. All the combs in the Langstroth hive are readily removable without the slightest annoyance either to the beekeeper or the bees. Langstroth did his work so well that he left very little for future inventors to do.

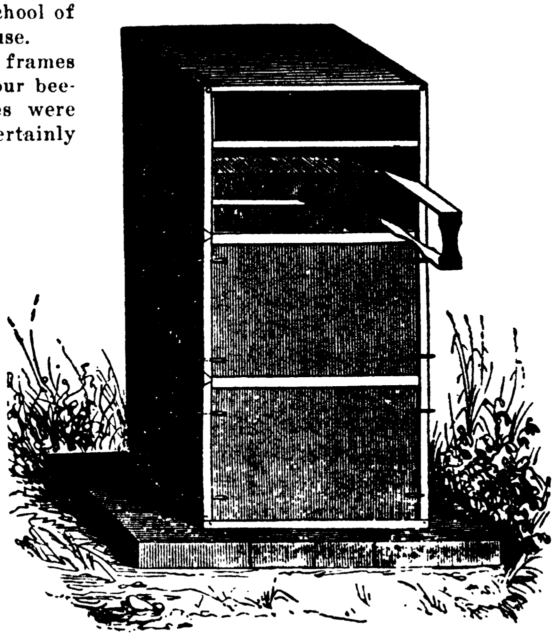
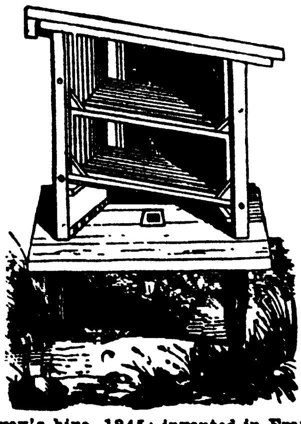


Fig. 5.—Prokopovitsch's hive, 1830.—From Framiere.

Many have tried to improve his hive, but in most cases the so-called improvement has proven to be a backward step. The striking feature of the Langstroth


Debeauvoy's hive, 1845; invented in France before Langstroth's hive appeared.

hive is the provision for a bee-space on all sides of the comb. This bee-space can not be less than ¼ of an inch nor more than ⅜. This alone was a great discovery, and placed Langstroth far above the mere inventor. (See Bee-space and Frames; also A B C of Beekeeping.)

From his writings it is evident that Langstroth knew nothing about what others had done before him in this line; and it is apparent that his invention was the result of a profound study of the bee and its habits. To some extent he was misled by others into thinking that the principle of the Langstroth hive had been discovered by Dr. Dzierzon independently, whereas it is now proven that the German beekeeper had no claim to the invention of the hanging movable comb, to say nothing of the bee-escape and the movable roof, which are essential features of the hive.

Langstroth's invention, accompanied by an excellent treatise on the art of keeping bees, created a revolution in beekeeping in a short time, linking his name with that of Huber as the two founders of modern apiculture.

HIVES, MANIPULATING.—See Manipulation of Colonies.

HIVE-STANDS.—See Apiary.

HOLLY (*Ilex opaca*).—American holly. White holly. A small evergreen tree, 20 to 50 feet tall, with a trunk sometimes six feet in circumference. Bark smooth and grayish white, twigs light brown. The leaves are elliptical, leathery, spiny-toothed, dark green, shining above and dull beneath, with bright-red berries in the axils. As in the common gallberry, the flowers are small, white, and a part are pistallate and a part staminate, the staminate being clustered and the pistillate solitary. Usually only one kind of flower occurs on an individual tree. Holly extends throughout the southern states from Florida to Texas, and in the Mississippi Valley northward to Missouri, and along the coast to Massachusetts, but is not abundant north of Virginia.

American holly is widely distributed in Georgia, but is seldom very common in any one locality. The flowers expand in April, and, although the honey is never obtained pure, it is undoubtedly excellent. In Florida it is confined to the northern part of the state, where it blooms a little earlier than in Georgia. The honey is always mixed with that from other early spring flowers; for example, on the eastern coast it forms a fine blend with the honey of the saw palmetto. In South Carolina holly is also considered a valuable honey-producer and the odor of the flowers is very noticeable in the apiary when the trees are in bloom. In Massachusetts the holly does not flower until June. There is in this state a variety with yellow fruit.

HONEY.—According to the Century Dictionary, "Honey is a sweet viscid fluid collected from the nectaries of flowers and elaborated for food by several kinds of insects, especially by the honeybee (*Apis mellifica*)." An accepted German definition is, "Honey is the nectar obtained from flowers by worker bees, which, after modification in the honey-stomach of the latter, is stored in the cells of the comb for the nourishment of young brood." In this country the food standards consider "honey as the nectar and saccharine exudations of plants." This comes about in that many plants contain sugar in their saps, and, when an exudation of sap takes place and the water in the sap is evaporated, a saccharine residue remains, which is gathered by the bees. Also, many trees exude a sweet sap when stung by some insect, and this is also gathered by the bees. (See Honeydew.)

Physically considered, honey may be a solid block resembling a pound cake of creamery butter or it may be semi-solid or decidedly liquid. The old idea that crystals of dextrose in a honey indicated beyond doubt that the product was badly adulterated still holds sway among many people. (See Granulation of Honey and Bottling Honey.)

In color, honey may be water-white, or it may grade through the yellows to the brown into the seal brown and nearly to the black. It has been known to be decidedly red in color, and again at another time to have a greenish tinge—none of these indicating by any means the addition of artificial colors, but being due entirely to the source of the bees' food. Honey may be as mild or as strong in flavor as one can imagine, and may possess all the fragrant aroma imaginable. Yet in each case it will be absolutely pure. (See Honey, Colors of.)

Consumers are very apt to jump to conclusions as to the purity of this product on

account of these various flavors and aromas. A person used to clover or alfalfa honey would immediately say buckwheat honey is not honey at all; and, vice versa, one used to buckwheat honey would say clover honey is nothing more than a mild-flavored sugar syrup. (See Honey, Flavors of.)

As regards composition:

Honey belongs to the carbohydrate foods. It is practically a solution of the two sugars dextrose and levulose, in nearly equal proportions, in water with sucrose in varying small quantities, naturally flavored and containing aromas imparted to it by the flower and by the bee. Early analyses of honey were very incomplete. Hassall, in his "Food—Its Adulterations and the Methods for their Detection," published along in the sixties, reports moisture, cane sugar, glucose, insoluble matter, and mineral matter in four samples. In his report he states, "With the exception of these, so far as we are aware, no reliable analyses have yet been made."

Wiley in Part 6, Bulletin 13, Division of Chemistry, published in 1892, gives a rather complete analysis of a number of American honeys. But by far the most complete and exhaustive study of American honeys was made by Browne and published in 1908 as Bulletin 110, Bureau of Chemistry, United States Department of Agriculture. Following this, in 1912, Bryan published results of examinations of imported honeys from Cuba, Mexico, and Haiti as Bulletin 154 of the same bureau and department. Miss Alice R. Thompson in 1908 published results of the examination of Hawaiian honeys as Bulletin No. 17, Hawaiian Agricultural Experiment Station.

Abstracting these, we obtain some interesting facts, and at the same time a fairly complete analysis of representative American honeys, together with those likely to enter the American market.

Browne made a classification of his samples according to floral origin; that is, he placed all those supposed to be obtained from clover together, etc., and then attempted to draw some conclusions as to physical and chemical constants of each variety. While the results do show some conformity to type, they are not as close as could be desired, for examination of the pollen found in the samples

Determination	AMERICAN Levorotatory honeys 92 samples			AMERICAN Dextrorotatory 7 samples			CUBAN 33 samples		
	Av. %	Max %	Min %	Av %	Max %	Min %	Av %	Max. %	Min. %
Water	17.70	26.88	12 42	16 09	17 80	13 56	21 07	27.00	16.05
Invert sugar	74.98	83.38	62.23	66.96	71.69	64.84	71 77	77.56	68 09
Sucrose	1.90	10.01	0.00	3 01	5 28	0.61	0.94	2 99	0.00
Ash	0.18	0.90	0.03	0 81	1.29	0.29	0.22	0 39	0.07
Dextrin	1.51	7.58	0.04	9.70	12.95	6.02	1.43	3.98	.0.29
Undetermined	3 73	7 45	0 04	3.43	4.95	1.57	4.57	8.07	1.23
Total	100.00			100 00			100 00		
Free acid	0.08	0.25	0 04	0.12	0 19	0.05	0 14	0.43	0.00
Reducing sugar as dextrose	71.08	79 86	59.61	64.15	68 68	62.12	68 74	74.29	65.22
Polarizations:									
Direct—									
Immediate	−11.24	−21.90	† 3.70	†14.77	†24.90	† 6.70	−12.79	−20.00	− 6.05
Constant	−14.73	−24.80	− 0.30	† 9 43	†17 75	† 3.60	−14.12	−21.10	− 8.60
Bi rotation	3.49	11.60	1.40	5.34	7 15	3.10	1.33	3.55	.20
at 87° C.	†10.15	†23.70	† 0.50	†32.20	†35 80	†28.50	†10 94	†17.00	† 6.00
Invert—									
20° C.	−19.16	−29.26	− 1.32	† 5 47	†14.96	− 2.53	−15.81	−23.43	− 8.86
at 87° C.	† 7 91	†23.21	− 0.66	†27 56	†34 98	†20 90	† 9.56	†15.40	† 4.51
Difference	27 07	33 55	23 32	22 09	23 43	20 02	25 37	28 49	23.05

Determination	MEXICAN 23 samples			HAITIAN 16 samples			HAWAIIAN Levorotatory honeys 14 samples			HAWAIIAN Dextrorotatory 35 samples		
	Av. %	Max. %	Min. %	Av %	Max. %	Min. %	Av. %	Max. %	Min %	Av %	Max. %	Min. %
Water	21.04	24.40	19.43	22.02	25.05	18.60	18.19	20.72	16.94	16.24	18.94	15.12
Invert sugar	72.30	75 01	69.27	73.73	76.73	69.15	73 40	80 32	65.56	61.76	67.52	55.92
Sucrose	0.80	3 98	0.00	0.55	2.44	0.00						
Ash	0.25	0.58	0.13	0.16	0.45	0.06	75	1.50	33	1.53	2.10	.98
Dextrin	1.45	3.48	0.52	0.53	1.65	0.26						
Undetermined	4.15	6.30	1.35	3.01	5.46	0.66						
Total	100.00			100.00								
Free acid	0.19	0.35	0.07	0.12	0.28	0.03						
Reducing sugar as dextrose	69.25	71.87	66.35	70.62	73.49	66.23						
Polarizations:												
Direct—												
Immediate	−12 41	−22.90	− 7.25	−15.76	−19.60	−11.30	−12.5	−19.7	† 0.1*	†13.4	†24.5	†0 5*
Constant	−13 21	−24.15	− 8.50	−17.22	−20.65	−12.50						
Bi rotation	0.80	1 60	0.00	1.46	2.60	.85						
at 87° C.	†11.27	†15 70	† 3.70	† 7.66	†10.70	† 4.35						
Invert—												
20° C.	−14.84	−26.07	− 9.35	−19.05	−22.66	−13.31	−15.3	−22.7	− 3.2*	† 8.2	†15.4	−4.2*
at 87° C.	†10 15	†13.42	† 2.86	† 6.58	†10.12	† 3.52						
Difference	24.99	28.93	22.77	25.63	27.17	23.43						

Hawaiian honey is calculated as dextrose instead of invert sugar † equals plus −equals minus. * at about 30° ‖ calculated as dextrose

showed that the bees had gathered nectar from some other flowers, although the prevailing pollen was that of the species under which the analysis had been classified.

In this same bulletin is a rather exhaustive study of the several kinds of pollen found and the characteristics of the pollen of the various individual flowers. The quantity of pollen varied considerably in the samples, hence the examination for pollen can not give any index of the percentage of adulteration. From the kinds of pollen found one can judge with some degree of accuracy the kind of flowers visited, but it is hardly safe to say that, with the absence of a certain pollen, the nectar from that flower has not been gathered and stored.

In the preceding table are contained the analytic results of the examination, showing the average, the maximum and the minimum figures for American, Haitian, Cuban, Mexican, and Hawaiian honeys.

It is noted that the American as well as the Hawaiian honeys are divided into two classes, levorotatory and dextrorotatory. The former may be termed honeys under the National Food Law, while the latter are honeydew honeys. The standard of food products under the national law states that "Honey should be levorotatory, and should contain not more than 25 per cent water, not more than .25 per cent ash, and not more than 8 per cent of sucrose."

The quantity of ash stated is too low, as Browne's examination has shown that honey may contain as much as 0.90 per cent ash.

The analytical figures given in the analyses are for percentage of moisture, invert sugar, sucrose, dextrin, ash, and undetermined matter. The acidity of the honey samples has also been given.

In American honeys there is an average of 3.73 per cent of undetermined matter. The composition of this material is the subject of much work now, and the substances found in this class by the chemist are often the deciding figure in determining the adulteration of honey with commercial invert sugar.

The composition of the sugars reported as invert sugar, viz., percentage of dextrose and levulose, are sometimes of value. Taking Browne's results for the average of the various species of honey we find:

Kind of honey:	Dextrose.	Levulose.
Alfalfa	36.85%	40.24%
White clover	34.96	40.24
Alsike clover	36.06	40.95
Sweet clover	36.78	39.59
Catsclaw	38.21	40.81
Mesquite	38.04	41.03
Locust	35.98	40.35
Dandelion	35.64	41.50
Goldenrod	34.45	37.85
Aster	33.93	41.31
Apple	31.67	42.00
Raspberry	33.57	41.34
Buckwheat	36.75	40.29
Wild buckwheat	35.39	41.36
Cotton	36.19	39.42
Basswood	36.05	39.27
Sumac	33.72	37.61
Tupelo	**24.78**	**48.61**

In every case the levulose predominates. This is of value, as in commercial invert sugar the two are equal or the dextrose predominates. (See Invert Sugar.)

The distinction between floral honey and honeydew honey is only possible by means of the polariscope. If a solution of the honey turns a polarized ray of light to the left it is levororatory, and the honey is a true honey; but if it turns the ray to the right it is a honeydew honey, provided no commercial glucose has been added.

For further consideration see Granulated Honey, Extracted Honey, Honeydew, Honey, Food Value and Medicinal Value of, and Nectar.

Some Physical Peculiarities of Honey

Honey, from the standpoint of physics, is fundamentally a supersaturated solution of sugars in water, and as such behaves in general like other such solutions, with certain modifications due to the other constituents. Under Granulated Honey and Honey, Science of, it is shown that on standing, practically all honeys show the formation of dextrose crystals, due to the fact that the honey contains as a rule more dextrose than can readily be held in solution at ordinary temperatures. This formation of crystals is, of course, a physical phenomenon, since no chemical change occurs in granulation. The old myth that granulation is a guarantee of purity is, of course, erroneous, for any comparable sugar solution will crystallize, and some such solutions form crystals more quickly than do most honeys.

As has already been indicated, the story of granulation is not always simply the throwing down of excess dextrose, for the story is more complicated than that. (See Granulated Honey.) It was shown some years ago in some work in

the federal Bureau of Standards that the three sugars, sucrose, levulose and dextrose, in solution have a physical influence one upon the other with respect to the formation of crystals, and that when a supersaturated solution of two or three of these sugars has just the right proportions of sugars, the formation of crystals is inhibited. If it were not for this physical effect, all honeys would doubtless granulate even before we could get them extracted.

Viscosity

Any sugar solution becomes thicker at low temperatures, as is suggested by the old comparison of a slow person to molasses in January. This means that the viscosity is increased, and all beekeepers are familiar with the greater viscosity of honey at lower temperatures. The thickness, or slowness in flowing, of honey is usually called "body." It is also well known to all beekeepers that a honey with a low water content, that is thoroughly ripened by the bees, is heavier in body than an unripe honey. For any given temperature, it is usually true that the lower the water content, the heavier the body of a honey, but it is important to point out that water content does not alone affect the body of a honey, at least not of all honeys. A striking example to the contrary is shown in the celebrated heather honey of Europe which is so viscous that it will not flow from an overturned pound jar but which does not have a water content as low as have many western American honeys which flow more freely. Just what heather honey contains which gives it this high viscosity is apparently unknown. A few American honeys show slight evidences of such behavior but by no means to so marked a degree. (See Honey, Specific Gravity of.)

Freezing Point

Honey, of course, never freezes at any temperature at which it has been kept and there appear to be no records of its having been exposed to such extremely low temperatures as that of liquid air. The freezing point of a sugar solution is lowered by the increased concentration of sugar, and at the same time the boiling point at ordinary barometric pressures is raised. It is, of course, well known that the boiling point of honey is higher than that of water, yet we can not make observations on the boiling point of honey without causing disintegration changes which ruin it, except under partial vacuum. The lowering of the freezing point depends not on the weight of the sugar in solution for any given amount of water but on the number of molecules of sugar in solution in water, or whatever the solvent may be. A solution of cane sugar containing a given weight of sugar freezes at a higher temperature than does a solution containing an equal weight of dextrose or levulose, since the last two sugars are simple sugars and a given weight contains twice as many molecules.

The fact that honey solutions do not readily freeze has been put to practical use in the making of anti-freeze solutions for automobile radiators. It is not the intent here to dilate on the advantages or disadvantages of the use of this solution, for there are already enough bee enthusiasts who have tried it and who later have had their engines cleaned. They may advocate or condemn it as they see fit, but it has always seemed to this writer a sort of sacrilege to use honey for any such base purpose, when alcohol is available and can be put to no better use.

The peculiar thing about diluted honey is the fact that when the temperature for any given density of honey solution reaches the point at which freezing would normally be expected to occur, the solution does not freeze to a solid mass but instead forms a mushy mass which is still capable of slow flowing. When a sugar solution of the same density and the same number of molecules is so treated, it frezes to a solid mass, so that, for some reason still a mystery, honey behaves differently and in a manner more suited to such purposes.

Water Absorption

The absorption of water by honey is of course, a physical phenomenon, and it is one which not only makes it necessary for the beekeeper to see that honey is not exposed to moist air, but it is also one which causes certain peculiarites in some persons who eat honey. (See plasmolysis under the head of Honey Antiseptic, page 400. Also see Honey, Sensitization of.)

Why Some People Can Not Eat Honey

There are persons who experience severe pain shortly after eating honey, nothing more serious than a sharp stomachache, but enough to make them think at times that honey is injurious. When a heavy sugar solution like honey enters

the stomach, a strong osmotic action is set up, which means that the honey is extracting moisture from the walls of the stomach. Such a strong action, which might be compared to a pumping action through the walls of this organ, is enough in some persons to cause pain. There is no space available here for a discussion of osmosis, but it means simply that on two sides of the membranes lining the stomach there are two solutions, one, honey which is concentrated in sugar, and the other, the body fluids which are less concentrated in sugar. In osmosis, there is a tendency for fluid to pass from the less to the more concentrated side, which means that moisture passes to the cavity of the stomach. If this action is adequately strong, and if the stomach is sensitive to such action, pain may result. All of which is merely another way in which honey may be misunderstood by erroneous use. The logical thing in such cases is to eat honey diluted with water or with considerable food, and the occurrence of such pain in no way implies anything injurious in honey. (See Honey Antiseptic.)

Specific Gravity

It is, of course, well known that honey weighs more than a like volume of water, and this comparison with water in weight is called the specific gravity. Honey usually has a specific gravity of 1.40 to 1.45, which means that it is that many times as heavy as water. In common practice we say that honey weighs about 12 pounds to the United States gallon, instead of slightly over 8.3 pounds as does water. (See Grading Honey and also Specific Gravity of Honey.)

A low water content is associated with a high specific gravity, so that it has been assumed that if the specific gravity is high, fermentation will not occur. This assumption has often been made by beekeepers and honey packers, who have used the specific gravity test to determine the probability of fermentation, but it is unfortunately not a valid test. As has already been pointed out, when granulation occurs and dextrose crystals are thrown down, a larger portion of the original water of the honey remains with that part that is not in crystal form, so that fermentation may occur in a solidly granulated honey of high specific gravity, in which fermentation will not occur so long as the honey remains in liquid form.

Mixing of Different Honeys

An astonishing physical characteristic of honeys is the tendency of various honeys not to mix thoroughly without considerable stirring. This is best shown when a thick and a thin honey are extracted the same day and run into the same tank, for within a few hours most of the thin honey will rise to the top and will remain separate. The thin honey at the top is, of course, liable to fermentation, thus spoiling the entire quantity. Similarly when honey absorbs moisture from the air, a thin layer remains at the top and thus increases the danger of fermentation. Since in the first case mentioned both honeys are supersaturated solutions of the same sugars, one might expect them to mix thoroughly by diffusion or by the stirring which they unavoidably get when poured into the tank, and many beekeepers have doubtless been surprised to see the later separation.

When honeys are blended, considerable stirring is essential to insure a thorough mixing of the different honeys added. This introduces a new trouble, for agitation of honeys is apt to cause air bubbles to be incorporated in the honey, thus increasing the probability of granulation, so that in blending, honey must not be rapidly stirred just before bottling anu during the final heating.

Effect on Polarized Light

Perhaps the most interesting and important physical characteristic of honey is the effect of the various sugars on turning polarized light to the right or left. This phase of the subject is very fully discussed under Science of Honey and need not be mentioned further, except for the purpose of making our incomplete catalog of physical oddities more nearly complete. The entire discussion of colors of honey and their origin of course finds its proper classification under physical characteristics, and these have also been discussed. (See Honey, Science of.)

The Degree of Granulation

The degree of granulation which a particular sample of honey may reach, as well as the length of time it takes to granulate, is another physical characteristic worth noting and forms roughly an index to its purity. Honeys high in dextrose are prone to granulation. This characteristic of alfalfa honey is well known. Conversely, honeys low in dex-

trose do not granulate readily. Note that tupelo, a non-granulating honey, shows only 24.73 per cent of dextrose, while alfalfa, an early granulating honey, shows by the table, page 396, 36.85 per cent. (See Science of Granulation under Granulated Honey.) Impure honeys, such as honeydew honey and honey adulterated with glucose, do not granulate as readily as pure honey. Sage and tupelo by nature seldom granulate. This characteristic is utilized by packers in preparing a product which will not readily crystallize on the market when exposed to changes in temperature. (See Granulated Honey.)

Ordinarily honey is judged by its color, flavor and density. There is an almost endless variety of flavors, making it practicable to suit the most exacting connoisseur. The flavors, like the evanescent aroma of honey, are very difficult to describe and really can not be satisfactorily communicated through printed description. Alfalfa, buckwheat, basswood, cotton, orange, and several other kinds of honey have a characteristic flavor and aroma which any one accustomed to them can recognize without difficulty. The presence of honeydew is usually detected by a burnt-sugar flavor. The flavors of some of the prominent honeys are described under the respective plants. (See also Honey, Flavors of.)

Color is a fair guide, but not always so, for the famous heather honey of Europe is quite dark, and yet no honey stands higher in popular esteem on that continent. (See Colloidal Substances in Honey.)

It has been the custom of a number of honey producers to market their product under such names as "white clover honey," "sage honey," and "pure orange honey." In regard to this practice Bulletin No. 110 of the Bureau of Chemistry makes the following statement: "Bottled honeys are frequently labeled by some floral designation, and these honeys, even when within the standard, often show a suspicious variation from the analyses of such honeys of known floral origin, especially as regards sucrose content. The microscopic examination of these honeys frequently shows an almost complete absence of pollen from the flower in question. Beekeepers and bottlers of honey are sometimes extremely careless in the labeling of their products and apply the name of almost any flower, thinking that they keep within the requirements of the law so long as their product is pure honey. This is a mistake, as the product should be labeled exactly according to its origin." (See Labels for Honey.)

HONEY, ACIDITY OF.—Along in late 70's and the early 80's of the last century there was some silly talk to the affect that bees use their stings as trowels to form the cappings of honey combs and that when the job is done they thrust their stings through the cappings and thereby inject bee poison, supposedly formic acid into the honey. As this acid is antiseptic, it was argued that honey was a preservative.

Although the sting trowel theory was absurd on the face of it, it occupied columns and columns of space in some bee journals at the time. From there it found its way into the public press carrying the implication that honey contains a poison and therefore is not fit to eat. Even some medical men hold that it is the formic acid that causes the slightly burning sensation when honey is eaten.

In the first place it is doubtful if formic acid is the active constituent in bee venom. (See Stings.) In the second place, it is now proven that the acid in honey is malic and citric and not formic and that while the latter may be present, it will at most be only a trace, too little to have any effect one way or the other. Malic acid is that which is found in apples and other fruits, and, of course, is harmless. Citric acid is found in all citrus fruit like oranges, grapefruit and lemons.

The following references gathered by W. J. Nolan of the Bee Culture Laboratory, Washington, D. C., should dispel the old heresy that formic acid is an active constituent in honey.

Theodor Merl, Zeitschrift fur die Untersuchung der Nahrung und Genussmittel, Vol. 42, p. 250, reported that no formic acid was found in bees.

A. Hilger, ibid., Vol. 8, pp. 110-126, reported malic acid as a normal constituent of floral and coniferous honeys.

A. Heiduschka and G. Kaufman, ibid., Vol. 21, p. 375, determined volatile acids, including formic acid, on six samples and found very little formic acid. The same authors, Suddeutsche Apotheka Zeitung, Vol. 53, pp. 118-119; abstracted in Zeit. f. d. Unt. d. Nahr. u. Genussm. Vol. 32, p. 472, reported the presence of formic, lactic, malic, phosphoric and tartaric acids.

K. F. Farnsteiner, Zeit. f. d. Unt. d. Nahr. u. Genussm. Vol. 15, p. 598, reported the acidity of honey as being due only about one-tenth to formic acid and the rest mainly to malic acid. This reference also gives a literature review of the question of formic acid in honey up to 1908.

The Entwurffe zur Festsetzungen uber Lebensmittel of the Kaiserlichen Gesundheitsamte, Heft 1; Honig 1912 (?) or 1917 (?), reported the acidity of honey as due to malic acid with perhaps traces of formic acid.

E. K. Nelson and H. H. Mottern, Division of Food Research Bureau of Chemistry and Soils, Washington, D. C., after some very careful work reported that malic and citric acids were found in all samples of honey examined and that formic acid, formerly assumed to be an important acid in honey, is present in a relatively small amount.

It should be remarked perhaps that while the analyses of honey often show formic acid, that the chemists making such determinations jumped to the conclusion that the acid found was formic.

HONEY ANTISEPTIC.—Mention has already been made of the fact that honey contains two sugars, levulose and dextrose. The former is hygroscopic, or deliquescent, like salt—that is to say, it has ability to absorb moisture from the atmosphere or from any medium in which it may be placed. Whereas a solution of levulose will absorb moisture from the atmosphere more readily than a correponding solution of dextrose, in its power to destroy bacterial cells by plasmolysis, a dextrose solution is equally as effective as levulose, since the osmotic pressures exerted by corresponding solutions of the two sugars are approximately equal. In other words, destruction of the vegetative cells is due to osmotic pressure exerted by the two sugars in solution. As honey contains these two sugars, it has the power to dry up certain bacteria in vegetative form.

C. A. Browne, formerly head of the Bureau of Chemistry, Washington, D. C., and an expert in the chemistry of sugars, says that under certain conditions honey is even more hygroscopic than either invert sugar or levulose.

As milk is a common carrier of some diseases, it was once thought that honey might likewise do the same. Dr. W. G. Sackett, bacteriologist of the Colorado Agricultural College, Fort Collins, Colorado, was one among the number who entertained this view. With the definite purpose of proving his theory, he conducted some elaborate experiments, the results of which were published by the station in Bulletin No. 252. He scientifically introduced various disease organisms that afflict the human family into honey to determine whether they could live and thrive in such a medium. Quite to his surprise he found that all such microorganisms so introduced into honey died within a few hours or a few days. He summarizes the finding in this statement: "The longevity of the typhoid colon group in honey is very limited. The probability of honey acting as a carrier of typhoid fever, dysentery, and various diarrheal affections is very slight." The following is a summary of his conclusions:

B. typhosus was no longer present in the pure honey after 48 hours. This is the germ which causes typhoid fever.

B. para typhosus (A and B) were dead in pure honey after 24 hours. These germs cause diseases very similar to typhoid fever.

B. fecalis alkaligenes was killed in pure honey inside of five hours.

B. proteus vulgaris died out in pure honey after four days.

B. suipestifer—the culture was dead in the pure honey on the fourth day. The presence of this germ is often characterized by chronic broncho-pneumonia followed by septicemia.

B. lactis aerogenes died out in pure honey on the fourth day.

B. coli communis died out in pure honey on the fifth day. The presence of this germ is said to become "pathogenic in the case of ulceration in typhoid fever. It may enter the blood, causing peritonitis."

B. dysenteriae—ten hours' exposure in pure honey was sufficient to destroy this organism. As the name well indicates, this is the germ which causes dysentery.

B. enteritidis was dead in pure honey in 48 hours.

Dr. A. P. Sturtevant, bacteriologist in the Bureau of Entomology, Washington, D. C., confirming this says that honey has the peculiar and distinctive property of absorbing moisture from anything that comes in contact with it. A certain amount of moisture is necessary to maintain life in all living organisms, so when bacteria comes in contact with honey and this vital amount of moisture is withdrawn it dies.

A. G. Lochhead, Division of Bacteriology, Ottawa, Canada, says:

Honey in Relation to Bacteria

Honey is fortunately a very unsuitable medium for the growth of bacteria for two important reasons. In the first place, honey is acid in reaction, a circumstance which renders it a very unfavorable place for bacteria in general to grow in, but very few types being able to thrive in any solution having the degree of acidity which honey possesses. A second very favorable factor is seen in its high sugar content approximating 80 per cent. Honey, therefore, represents a medium of high osmotic pressure which is exceedingly unfavorable to all but a relatively small group of bacteria, for most species are unable to grow and multiply in solutions of more than 15 or 20 per cent sugar. Hence, through a happy combination of circumstances, namely, acidity and high density, honey may be regarded as practically immune from bacterial action. The probability of honey acting as a carrier of typhoid fever, dysentery and related diseases is very slight indeed.

It is clearly evident from all this that

disease germs that afflict the human family could not live in honey.

Germs of Bee Disease Not Transmissible to Human Beings

The question may be raised at this point if honey may be a carrier of the germs of American foulbrood (*Bacillus larvae*), why could not germs that afflict human beings be likewise carried? The explanation is simple. The organisms that attack the human family, according to the bacteriologists, are generally in the "vegetative" form, without spores, and as such they can be readily destroyed. The organism that causes American foulbrood develops spores and these can exist in the honey. They may reside there for years. (See Foulbrood.)

There has been some very silly propaganda that occasionally crops out in the newspapers to the effect that honey from a colony affected with American foulbrood should not be sold on the general market, because, forsooth, it might carry disease to human beings. In the first place, as already pointed out, a disease of bees, either in spore or vegetative form could not be communicated to human beings. In the second place, a super of honey coming from a colony affected with this disease in all probability would not contain enough germs to produce disease even among bees. Jas. I. Hambleton, the head of the Bee Culture Laboratory of the United States Department of Agriculture, has shown that the spores of *Bacillus larvae* must be numerous enough to cause a real infection. (See Gleanings in Bee Culture, page 588, 1926.)

As a summary, it may be stated that honey, on account of its hygroscopic qualities, can never be a carrier of most of the micro-organisms that cause disease in the human family. In this respect honey is decidedly different from ordinary milk, which is in itself a food to some of these organisms.

No one should get the impression from the reading of the foregoing that the eating of honey, because it is of the nature described, would cure disease in the human body. In itself it is not a carrier of disease to human beings as might be in the case of milk.

HONEY, ATHLETES USE OF.—Athletes, just before and during their work, often use honey in place of any other sugar because of its ability to supply energy quickly. In this respect honey occupies a unique position among energy foods. Ethel Hertel in the Third Wrigley Marathon Race, held at Toronto, where she won the crown of the world's champion woman swimmer, used honey before and during this race. She says: "After consulting a number of athletes (runners, boxers, oarsmen and others) I discovered that they were using honey." After trying several kinds she found Canadian honey "to be more easy to digest and which did not give gaseous troubles that other products did."

Any one who is very tired from overwork, either mental or physical, can quickly dissipate that jaded feeling by drinking a big glass of hot water in which one or two tablespoonfuls of honey has been thoroughly stirred. It acts quickly. Ordinary sugar and water will not act quickly because the sugar must first be inverted before it can go into the blood stream.

The very fact that honey is absorbed by the blood without change, that is beneficial to sick people and people of weak digestion or weak heart, goes to show that honey ought to be beneficial to the well and the healthy, especially athletes, farmers, or laborers, who do very hard physical work. A letter to the General Manager of the Ontario Honey Producers' Association from W. L. Finlay, D. D. S., Director of Athletics of the Young Men's Christian Association of Toronto, will be of interest:

THE TORONTO YOUNG MEN'S CHRISTIAN ASSOCIATION
Central Branch, 40 College Street.
Toronto, November 12, 1926.

General Manager,
Ontario Honey Producers.,
47 Wellington St., E., Toronto 2.

Dear Sir:—It may interest you, as a honey man, to know what is being done in athletic circles with your product.

For almost three years the members of Central Y. M. C. A. Walkers' Club, the premier club of its kind in Canada, have been using Beekist honey as a staple article of diet.

Following extensive medical research work on diet and athletes' endurance, in which was involved estimations of blood sugar before and after competitive walks, these members aforementioned were advised to incorporate in their bill of fare a large quantity of natural sugars, and the article deemed most suitable by medical opinion was honey.

This type of athletic activity in which these men are engaged demands great stamina and endurance, and the food problem with us is one that demands close attention.

Honey has the following advantages over other sugars:

1. It is non-irritating to the delicate membranes of the digestive apparatus.

2. It is assimilated rapidly and easily.
3. It quickly furnishes the demand for energy.
4. It enables the athlete to recuperate rapidly from severe exertion, and the men using it show less evidence of fatigue, according to standardized medical tests.
5. As far as our research work has demonstrated, the use of honey spares the kidneys, lessening tissue destruction.
6. It has a natural and gentle laxative effect.
7. It is easily obtained and it is inexpensive.

The group of athletes already mentioned have been very successful in the past and are now in the throes of intensive training for the largest walking race in the world, a 10½-mile event, which takes place annually in New York on Thanksgiving day, November 25.

Trusting that this little summary of our use of your product may be of interest and value to you, I remain, Yours faithfully,
(Signed) W. L. FINLAY, D. D. S.,
Directors of Athletics.

In Gleanings in Bee Culture for 1931, page 220, Natt Dodge writes:

The Role of Honey in Athletics

In their work of promoting the wider use of honey, beekeepers may derive much assistance from a knowledge of what has been done and what is being done throughout the country. For example, what beekeeper in talking with the principal or athletic director of his local high school would not make a most effective impression if he would mention that Coach "Babe" Hollingberry of Washington State College football team (which on January 1, 1931, as champion of the Pacific Coast Conference, met the team of the University of Alabama to decide the East-West champion) had honey on the team's training tables during the period of intensive training prior to the game, and is a firm advocate of the use of honey as an ideal energy food for athletes? What beekeeper, given an opportunity to speak before a group of children regarding bees and honey may not add double weight to his words by telling the youngsters that Helene Madison, sensational seventeen-year-old girl swimmer who broke twelve world and twenty-six American records in eight months of 1930, is encouraged by her trainer, Ray Daughters, to use honey as her major sweet? Hero worship is a powerful force in the children's world. Boys and girls religiously and enthusiastically copy the habits, mannerisms, and dress of those whom they admire, especially in the field of athletics and sports.

There have been a large number of other testimonials from athletes who have used honey alone or in place of sugar at intervals during their very long runs or other athletic contests. Honey goes into the blood stream almost immediately, and as an energy food there is probably nothing else its equal. See Dr. Lorand's works, referred to further on.

HONEY BEVERAGES.—Any honey of good body and flavor can be used in the preparation of a hot cereal or coffee drink or in any of the sodas, pops, and lemonades; but it should be made plain that a good, thick, ripened honey will not dissolve readily in an ice water. It must first be greatly thinned down in hot water (not boiling) when it can be put into the ice water. If not sweet enough more honey hot water can be added. Many people fail to make a good lemonade because the undiluted honey is poured into the ice water and, of course, the drink is too tart.

There is nothing finer among the soft drinks than a honey lemonade or a fruit punch. If the soda fountains only knew of the superiority of a honey sweetened lemonade, they would sell large amounts of it. It is up to the beekeeper to acquaint the soft drink dispensers with this fact. When that is done there will be another outlet for honey.

The soda fountain dispensers should be told that honey blends wonderfully well with any fruit juice. A honey lemonade can be improved by adding grape, cherry, orange, pineapple juice.

The following are some of the honey drink recipes carefully worked out by Mrs. Jensen, Secretary of the American Honey Institute. The author wishes to commend the first one—a honey cereal. If one drinks too much coffee at night and can't sleep there after, he will find this cereal drink a delightful substitute:

Honey Cereal Coffee—Use 1 egg, 1 cup honey (preferably dark), 2 quarts wheat bran. Beat the egg, add honey, and lastly the bran, and stir until well blended. Put in oven and brown to dark brown, stirring frequently, being careful the oven is not too hot. To prepare the coffee, allow one heaping tablespoonful to a cup of hot water, and boil for at least ten minutes.

Hot Honey Lemonade—Hot honey lemonade is particularly valuable in relieving the grippe. When suffering from a cold, take a hot honey lemonade just before retiring. 4 tablespoonfuls lemon juice mixed with 4 tablespoonfuls honey. Add 1 cup boiling water. Drink hot.

Honey Lemonade—2 tablespoonfuls lemon juice mixed with 2 tablespoonfuls honey. Add 1 cup spring water or charged water. Pour in iced-tea glass filled with cracked ice.

Honey Fruit Lemonade—To 1 cup honey lemonade add 6 tablespoonfuls orange juice, 1 tablespoonful pineapple juice and 1 tablespoonful fresh crushed strawberries which have been sweetened with 1 tablespoonful honey, pour into iced-tea glass filled with cracked ice.

Honey Fruit Punch—1 cup honey, 1 chopped banana, 1 cup chopped pineapple, 1 large orange crushed to pulp, ½ cup preserved cherries, 1 quart grape juice. Pour over ice—stand 20 minutes—then serve.

Honey Iced Chocolate—2 teaspoonfuls cocoa, 3 tablespoonfuls honey, 1 cup milk. Let milk come to a boil. Mix cocoa and honey, remove heated milk from fire, add cocoa and honey mixture and a good pinch of salt. Stir well. Pour this mixture into iced-tea glass filled with cracked ice. Above amount will provide two servings. Top with whipped cream.

Honey Milk Shake—1 dip ice cream, ¼ cup honey, 1 cup milk. Blend honey with ¼ of the milk warmed, add cool milk and then ice cream. Shake well in malted milk mixer until blended.

Honey Milk Punch—1 cup milk, 2 tablespoons honey, juice of ½ lemon. Cracked ice or ice cream. Blend honey with a little warm milk,

add cold milk and shake until well mixed. Add juice of lemon and shake again. Add cracked ice or dip of ice cream.

Honey Egg Nog—Beat 1 or 2 eggs with rotary beater until very light. Add 2 to 4 tablespoons honey, depending on sweetness desired. Add to 1 quart of milk, mix well and drink as desired. May be enriched with Honey Meringue.

Honey Egg Milk Shake—2 eggs, 1½ cups evaporated milk, 1½ cups ice water, 6 tablespoons honey. Beat eggs and pour into mason jar. Add honey and shake well. Add remaining ingredients and shake. Add chipped ice and serve.

Three-in-One Honey Shake—1½ cups orange juice, ¾ cup grapefruit juice, 3 tablespoons lemon juice, ½ cup honey, ½ teaspoon salt, ½ teaspoon lemon extract, 6 cups milk. Combine the fruit juices, flavoring and salt. Blend honey with a little of the milk which has been warmed, and then add remainder of milk cold. Add milk-honey mixture gradually to fruit juice mixture until nicely blended. Chill and serve.

Honey Spiced Milk—Few gratings nutmeg, cinnamon or mace to taste, 3 tablespoons honey, 2 cups chilled evaporated milk mixed with 2 cups ice water. Blend spices with honey and add 3 tablespoons hot water to dissolve. Add to diluted milk, shake well. May be served warm or cold.

Honey Banana Milk Drink—⅔ cup bananas, mashed to pulp, 3 tablespoons orange juice, 3 tablespoons honey, few grains salt, ½ teaspoon almond extract, 2 cups milk. Mash bananas to a pulp and mix until the pulp is entirely separated to give a creamy mixture, add all of the remaining ingredients, blend thoroughly and serve in glasses with a garnish of whipped cream lightly sprinkled with nutmeg. Honey Meringue may also be used as a garnish in place of whipped cream.

Honey Chocolate—4 squares of sweet chocolate cut fine, ¼ cupful honey, 6 cupfuls milk, 1 cupful of boiling water, ½ teaspoon salt, 1 cupful thin cream. Mix the chocolate, boiling water, honey and salt, then cook over low fire until smooth, stirring constantly. Heat the milk and cream to scalding and add gradually to the chocolate mixture, stirring until well mixed. Cool slightly, then cover and place in refrigerator to chill. Serve cold but without ice added. May be garnished with honey meringue.

Picnic Honey Lemonade (3 gallons)—5 lbs. mildly flavored honey, 1½ quarts hot water, 2 quarts lemon juice (about 2 dozen lemons). Dissolve honey in hot water, add to lemon juice. Add enough ice water to make 3 gallons lemonade. Add cracked ice. This allows for ice dilution.

Lemon Tingle—Make honey lemonade as above and to each glass add ½ glass gingerale and ½ teaspoon Honey Mint Syrup.

Honey Mint Syrup—1 teaspoon Bee Brand Mint Extract or fresh mint leaves to flavor, ¼ cup honey, 2 tablespoons lemon juice. Combine lemon and honey, add mint. Keep in jar in refrigerator and use as desired.

Loganberry Cocktail—2 cups loganberry juice, 1 cup orange juice, 1 cup water, juice of 1 lemon, ¼ cup honey, ice. Blend honey with ½ cup of the water which has been heated. Combine remainder of amount of water and other ingredients. Ice.

Miss Van Deman of the U. S. Bureau of Home Economics, suggested the following in her broadcast on November 8, 1932, as

A Good Beverage for November Evenings—Bring to a boil 1 quart of sweet cider with about ¼ cup liquid honey, add a few grains of salt, and 6 or 8 short pieces of stick cinnamon, and as many whole allspice, and a dozen whole cloves. After heating let the cider and spices stand for several hours to develop flavor. Before you serve the cider, reheat, and strain out the spices.

HONEY, BIBLIOGRAPHY OF.—The literature on honey as a food and medicine is very extensive. The Bee Culture Laboratory, Department of Agriculture, has some two thousand references. It obviously would be impossible to give all of these here. Besides those from which quotations are made in this volume under the various heads of honey, the Bee Culture Laboratory has furnished us a bibliography of the more important references, which we are glad to place here, practically all of which are very favorable to honey.

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HONEY-BOARDS. — See Extracted Honey, and Hives.

HONEY BUTTER.—In a warm atmosphere or when the butter is soft from twenty to thirty per cent of good honey can be paddled in. The honey must be thoroughly worked in after which it must be kept in a refrigerator or it will soon become rancid. The proportion of honey to butter will depend upon the taste of the individuals or family who use it. Try the smaller proportion of honey first. One should not prepare too large a batch of the mix as it will not keep more than two or three weeks even under refrigeration.

A good mix of butter and honey is very fine and some people make up a batch for winter pancakes. The combination of the butter and the honey is just right to put on bread or pancakes without the addition of another or more sweet.

A much better mixture of honey and dairy cream has been worked out by Prof. P. H. Tracy of the Dairy Department of the University of Illinois. He thus describes it in Gleanings in Bee Culture for August, 1932:

One of the limiting factors in the use of honey as a spread has been its fluidity. This difficulty has been overcome, however, by a new product that is made by combining honey with heavy cream. The resulting mixture, when cool, solidifies so that it can be spread on bread or waffles with ease. Since the honey cream, as it is called, contains about 40 per cent butterfat, no butter is needed.

Although it is possible to use any type of marketable extracted honey, the milder flavored ones seem to meet with greatest approval when mixed with cream. Sweet-clover honey has been found to be very satisfactory.

To prepare honey-cream, a sweet cream containing at least 75 per cent butterfat should be used. To secure a cream of this test, it is necessary to change the usual procedure somewhat. The following method may be followed:

(1) Pasteurize milk by heating to 142°-145° F., 30 minutes.

(2) Separate without cooling, reducing the rate of inflow to about one-fourth or until a heavy viscous cream is discharged. An especially constructed cream spout may be secured for some separators that will permit this heavy cream to be discharged from the bowl without clogging.

(3) Heat honey to 130°-140° F. and mix with cream in proportions of 42 per cent honey (if mild in flavor) and 58 per cent cream.

(4) Package immediately. Glass or paper containers may be used.

Honey-cream should be kept refrigerated as it has keeping qualities somewhat similar to those of butter.

This product can be made by milk dealers or by farmers themselves. If the small separator is used to separate the high-test cream, it is advisable to secure the special tinware made by some companies for use on their machines.

Honey-cream because of its delicious flavor is meeting with widespread popularity and should prove to be a valuable outlet for additional butterfat and honey.—Prof. P. H. Tracy, Dairy Department, University of Illinois, Urbana, Illinois.

While this is much superior to the ordinary mix of butter and honey first described, it must be kept in a refrigerator, the same as ordinary butter. Of course, in cold weather it can be kept like butter as long as the winter lasts.

HONEY-BUYING. — See Marketing Honey.

HONEY CANDIES.—The word honey has come down through the centuries as an emblem of sweetness, flavor, goodness, and health. Its very name attached to a food or candy carries an appeal to the public. It has an advertising value recognized by bakers and candy makers alike. Honey cakes, honey bread, honey candies appear on the market under various trade names and the purveyors of these foods freely admit that the magic name honey alone helps to sell the product. There is nothing like a good name and in this respect honey among foods has a distinction quite unique.

Unfortunately there are some makers of candies who attempted to use the good name of honey on their product but used in fact very little honey. The National Food and Drug Administration has ruled that a honey candy shall use enough of honey so that the product shall carry the flavor of honey. For this reason some candies flashing the name honey have disappeared from the market, and rightly so, because the amount of honey used was too small.

Difficulties in Making a Honey Candy

It should be frankly stated that it is not an easy matter to make a really good honey candy, using enough honey to meet federal requirements, without its becoming sticky on standing, especially in hot weather. As explained under various places in this work honey contains one sugar, levulose, that is hygroscopic, that is, it draws moisture from the air. A candy containing honey unless provision is made to prevent it, will become sticky and unsalable on standing. This very quality is invaluable in cakes, cookies and breads, because it keeps them moist. There are two ways of overcoming this in candy: First, by the use of a combination of lactose or a milk sugar, and, second, by the use of some other sugar such as corn or cane sugar, skim milk or whole milk powder, or even commercial glucose.

There is another difficulty in the use of honey for candy making. Honey is seldom uniform in its proportions of its two principal sugars, levulose and dextrose. It varies again in its percentages, though small, of its minerals and of its colloids, of its water content and its degree of inversion. In general its low caramelization point must be taken into consideration. This is due to the varying content of levulose and colloids referred to further on under the general head of Colloids.

In preparing or trying out a formula for the making of a certain candy, it is highly important to use one source of honey of best quality, running not less than 12 pounds to the gallon. (See Honey and Specific Gravity of Honey.) The colloids in honey, while the proportions are relatively small, have a pronounced bearing on the ability of the honey to undergo heat. (See Colloids.) For example, sweet clover or alfalfa will stand more heat than orange or mountain sage honey.

Again, in some honeys, the proportion of levulose is about twice that of dextrose. Most honeys will have slightly more of levulose than dextrose. (See table under Honey, page 396.) Usually one source of honey from a given locality will have the percentages of levulose, dextrose and of the colloids nearly constant. For this reason it is always safer to procure as nearly as possible the same source of honey for each batch of candy.

It is because of this variability in honey that a formula or recipe that will work

well with one honey or one person may not give satisfactory results with a honey of a different source. Taking it all in all, one may have to cut and try with any recipe where another sugar is used before he can get a candy that is satisfactory and that will not become sticky in warm weather.

Two Schools of Candy Makers

There are two schools of candy makers. The one believes it is not possible to make a good, tasty honey candy without using milk sugar (lactose) milk powder, cane or corn sugar. The claim is made that a pure honey candy is too sweet and will soon cloy the appetite; that for reasons already explained it will as soon as warm or hot weather comes on, become sticky; that the coating of chocolate or wax will ultimately crack, allowing the honey within to ooze out with the result that the whole box will become sticky and unsalable. There is truth in all of this.

The other school of honey candy makers insists that a candy bearing the name honey should contain no other major sweet than honey.

Corn sugar is only about half as sweet as honey. It helps to correct the over sweetness of the pure honey and at the same time increases the dextrose content of the candy so that the relative amount of levulose that causes stickiness is reduced. But the great objection to corn sugar on the part of beekeepers has been the repeated attempts of the corn sugar and glucose makers to get a national law passed that would permit of these low sweets going into all foods without a declaration on the label. Such a law would permit a wide adulteration of honey. (See Adulteration of Honey.)

The Stratton Candy

Miss Nellie Stratton, of Youngstown, Ohio, finally conceived the idea of using lactose or milk sugar that is even lower in sweetening power than dextrose or corn sugar. This in combination with honey made a beautiful fondant that was apparently stable and which could take any flavor to give the necessary variety in a box of chocolates. This fondant coated with chocolate made a wonderful candy. But unfortunately as it began to age it became too hard. This she finally corrected by using whole sweet milk.

Dr. E. F. Phillips, mentioned so many times in this work, describes her achievement as follows in Gleanings in Bee Culture, page 460, for 1934:

Adding Milk Sugar Prevents Stickiness

Miss Stratton first found that by adding a small proportion of milk sugar to honey she could obtain a candy which failed to develop stickiness. Milk sugar is not ordinarily used in the making of candy, although it is reported that it has been so used abroad to some extent. Milk sugar fills a rather special and unique place in the human diet. Like cane sugar, milk sugar is a double sugar (Dissaccharide), each molecule being composed of one molecule of dextrose and one of galactose. Human ability to digest and to assimilate milk sugar is distinctly limited, and in this fact lies the secret of the benefits derived from this sugar. That portion of milk sugar which is eaten but not assimilated passes unchanged to the large intestine, there undergoes fermentation through the action of lactic acid bacteria normally present in the colon, and is changed to lactic acid. The lactic acid in the colon then modifies the reaction of the colon contents and brings it to normal. This normal reaction inhibits the development of putrefactive bacteria and facilitates the further growth of fermentative bacteria, with beneficial results to the health.

Milk sugars form crystals readily. At ordinary temperatures about six parts of water are required to dissolve one part of milk sugar. At similar temperatures, dextrose is soluble in an equal quantity of water, whereas cane sugar is much more soluble. Levulose is the most soluble of all the ordinary sugars and rarely crystallizes from a water solution. This tendency of milk sugar not to stay in solution caused Miss Stratton some difficulty, for after her fondant was made, crystal formation sometimes continued, and her candies became too hard. This puzzling problem she also met by further research.

Whole Sweet Milk Also Used

It was found that after a fondant is made by Miss Stratton's formula, relatively large amounts of whole sweet milk can be worked into the fondant by mere mechanical means. The milk need not be boiled and is used in its fresh, pure state. To understand what happens in this case, it is necessary to discuss somewhat the physical nature of a fondant. A soft candy such as a fondant consists of two distinct phases, a solid phase of small crystals and a liquid phase consisting of sugar solutions which adhere closely to the small crystals, giving the degree of firmness desired. To the surprise of those who worked with Miss Stratton's fondants, the solid phase consists solely of microscopically minute milk sugar crystals. One might have guessed that there would also be dextrose crystals present, from the dextrose in honey, but these do not occur and all the dextrose remains in the liquid phase. Granulated honey consists of a solid phase of dextrose crystals and a much more extensive liquid phase of a solution of levulose, dextrose, usually some cane sugar and whatever ingredients occur in the honey. Ordinary granulated honey is not more than fifteen per cent solid, however firm the product may appear. When whole milk is worked into the Stratton fondant, it increases the liquid phase and since this liquid has the ability to dissolve milk sugar, the further formation of milk sugar crystal is inhibited.

The final candy, aside from whatever flavors may be added, then consists only of honey, milk sugar and sweet milk. It would strain one's imagination to conceive of a candy containing more desirable ingredients, and the candy as finally devised is a genuine honey candy, without the use of cane or corn sugar, and with milk and milk sugar the only ingredients used with the honey.

The basic difficulty of stickiness of honey candy now having been overcome by means of the use of two ingredients of high virtues, there would seem to be an avenue for an increased

use of honey in candy making. So far this candy has not appeared on the market. At the very beginning of the depression, a small start was made in the manufacture of Miss Stratton's candies, but at that time she had not obtained adequate patent protection for this invention, and the addition of milk sugar had to be kept as a deep dark secret. Now there is no reason for secrecy. But the depression grew faster than the sale of these candies, so the effort was abandoned. Furthermore at that time Miss Stratton had not yet discovered the possibilities arising from the addition of whole milk, and so candies made by her present formulae have never been offered on the markets. It is to be hoped that some alert and extensive manufacturers of high class candies will shortly realize the opportunities which this invention offers for placing a candy of the highest quality on the American market.

It should be stated that this milk sugar and whole sweet milk with honey for the purpose of making a candy is patented and therefore not available to general public except on the basis of royalty. Those who desire to make the product will, of course, write Miss Stratton.

There are other ways for making a pure honey candy that are open to the public.

Granulated Honey Confections

One can use a pure hard granulated honey of good flavor, cut it up into squares of suitable size and then dip in chocolate. Or one can cut up comb honey into small squares, allow them to drip over night in a warm atmosphere and then coat with chocolate. Comb honey, if put into an ice box or refrigerator to chill, can be cut into pieces more readily. The work can be facilitated still further by cutting this cold honey with a thin sharp knife just removed from a pail of hot water. Where there is much cutting there should be a series of knives used in alternation.

The objection to ordinary granulated honey when coated with chocolate is that it will soon become sticky. Globules of honey will ooze through the coating.

The Root, New Zealand or Dyce cream described on page 372 can be improved by mixing in the honey before it is creamed, ground nuts and milk powder. The proportions of milk powder and the nuts will have to be determined by experiment because the formula may have to be changed for different honeys.

The mix when coated with chocolate will not weep or leak like the straight honey alone.

The Dyce creamed honey with milk powder after it has creamed in the refrigerators is cut while cold into small squares with a hot thin knife and coated with chocolate

It is well to experiment with a small batch before making a large one to determine the proportions of milk powder to honey.

Chocolate dipping is a messy job at best. It is important to have the temperature of the room as well as of the chocolate right, and to know how to dip.

Mrs. Malitta F. Jensen of the American Honey Institute thus tells how to dip chocolate:

Chocolate Dipping

Chocolate dipping is difficult. In the candy business it is considered a trade and girls work from two to three years before they become expert dippers.

There are difficulties besides lack of technique. It is often hard to secure the right kind of coating chocolate. This is specially prepared and is quite a different thing from the chocolate used for cooking. Usually it must be purchased from a confectioner and often he will not sell less than a ten-pound cake.

The equipment for chocolate dipping is relatively simple. A small double boiler, a fork or chocolate dipper, and boards or trays are the essential things. The chocolates should be dropped on the covered boards or trays so that they can be removed from the dipping table as soon as they are coated. The covering may be heavy waxed paper, but if you are doing much dipping it will pay you to have boards over which table oilcloth has been stretched and fastened in place. The oilcloth gives the underside of the chocolate the smooth, soft gloss which is desirable.

Break the shaved chocolate so it will melt readily. Put it into the upper part of a double boiler and place over hot water—not above 120 degrees F. Do not have a fire under the water, as you are apt to overheat the chocolate and this is fatal to good dipping. Stir the chocolate constantly while it is melting, so that the chocolate in the bottom of the container, next to the hot water, will not become too hot. Its temperature must never go above 110 degrees F.

If you are experienced it is better to dip with a large amount of the melted coating at one time, as it will remain at the desired temperature longer. But if you are inexperienced, you may find it better to take about a cup of the coating from the double boiler, work it until ready for use, dip as many chocolates as possible. A small enameled bowl with sloping sides is the most convenient utensil for holding the chocolate while working and dipping.

When the melted coating is taken from the hot water it should be worked constantly until it reaches the proper thickness for coating. Dipping experts always use the hand for this "working." Dipping must be done at just the right moment and quickly.

The tests for the right consistency are—temperatures (85 F.) and dipping a trial center. When placed on the board this coated center should be perfectly smooth, except for the little marking at the top, and should not have a projecting base. It should harden quickly.

The temperature of the room for dipping is quite as important as the temperature for the chocolate. The temperature should never go above 65 degrees F., and 60 F. is even better. When dipping at home, do not have steam in the room.

Where a candy contains only honey and no other sugar it is very important to make no larger batch than will be consumed in a short time. When warm or hot weather comes on, it is almost sure to become sticky unless the chocolate dipping

is well done. It should be remembered also that a pure honey unless reduced with another sugar less sweet will make a candy too sweet and cloy the appetite.

Equipment Necessary for Candy Making

Again Mrs. Jensen, just mentioned, makes these recommendations:

The Thermometer—A thermometer is essential in order to obtain uniformly good results in candy making. Experience can teach you to know when candy is done, either by its appearance, or by the "feel" of the "cold water test." But in gaining this experience you may waste much material and time. Even when you have once gained the experience, unless you make candy frequently you lose your skill. The thermometer eliminates the waste of time and material in learning to know when candy is done, and gives a reliable test for the temperature to which the candy should be cooked.

Either of two types of thermometer may be purchased—the chemical thermometer or the thermometer specially designed for candy making, with a metal back and an adjustable hook which fits over the side of the candy pan. The advantages of this latter type are that it need not be held in place while the candy is cooking, and it is not likely to break because of the protection of the metal back. Its disadvantages are that it is difficult to clean, and it can not be used with small quantities of candy in the saucepan because the bulb will not be covered. This type of thermometer should be moved from time to time along the side of the pan when the candy is being stirred, so that the candy will not scorch where the thermometer hangs.

Saucepans—Choose a saucepan of the proper size for the kind of candy to be made. Remember that all candy "boils up" and space must be allowed for this. The saucepan should have a smooth surface, because any rough spot may cause the candy to stick and burn. Copper, aluminum, agate, or tin may be used.

Spoons and Spatulas—Wooden spoons are desirable for candy making, because they do not become too hot to handle when left in the cooking candy. It is also easier to beat with a wooden spoon, because the handle does not cut into the hand.

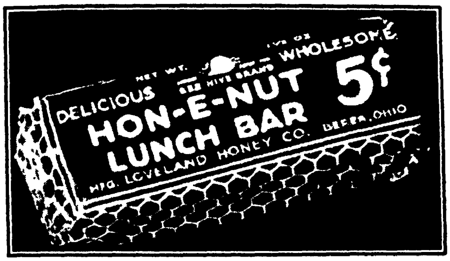
Measuring Cups—It is better to use a standard measuring cup than a tea cup. Many tea cups contain less than a half pint, and, if used, will throw other measurements out of proportion.

Professional Equipment—Even for home use, a slab with metal candy bars is useful. By means of the bars you can regulate the size of your block of candy, and hence its thickness. When the candy is firm the bars can be removed, and the candy is ready for cutting without the struggle of getting it out of the pan. If you decide to go into candy making on a commercial scale you will need additional equipment. The best thing to do is to visit a wholesale confectioner's supply house and select what will meet your individual needs.

Special Honey Candies—Before making honey candies on a commercial scale, get samples of all the honey confections now on the market. Compare the pieces you plan to make with these and see if you can improve. It is better to have a variety of honey centers and use no sugar if possible.

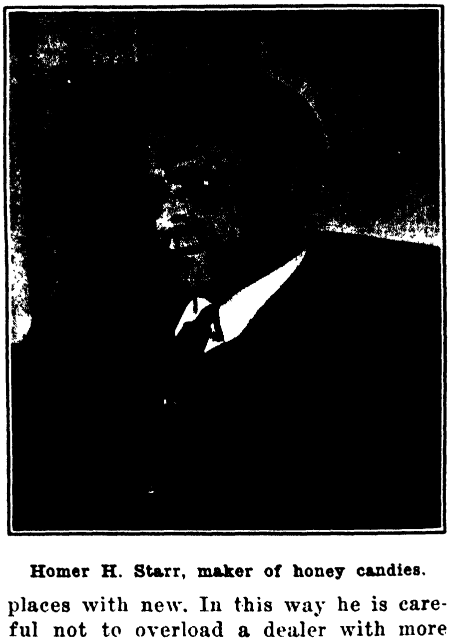
Beekeepers Who Are Selling Honey Candies

There are a few beekeepers who not only sell honey in tin and glass, but also sell honey candies. Usually they cut comb honey and hard granulated into chunks as explained and then coat them with chocolate. Among the number is Homer H. Starr of the Loveland Honey Co., Berea, Ohio. Mr. Starr sells his products, using



Close-up of Starr's Hon-e-nut lunch bar.

pure honey only, in the high class restaurants and groceries of Cleveland and vicinity. He makes his own deliveries and sees to it that his goods are properly displayed and if there are any left-over candies that show signs of becoming sticky he re-



Homer H. Starr, maker of honey candies.

places with new. In this way he is careful not to overload a dealer with more than can be sold in a short time and at the same time he overcomes the difficulty of spoilage.

He is a good advertiser. He displays his products in show windows; gives demonstrations in handling bees at schools. In fact, he sells all his own honey and is obliged to buy from his neighbors. His bees keep him busy during the summer

and his honey products keep him and one of his helpers busy during the winter. In this way he is a benefit to the honey market and a benefit to his brother beekeepers who do not have the knack of advertising and selling.

One of the Starr's candies is shown on the previous page.

Honey Candies Using Other Sugars

There is another class of beekeepers and high class candy makers who use percentages of glucose, corn sugar, cane sugar or milk powder with honey to make up their candies. In some cases as further on in the recipes there are much more of the other sugars than honey. The purpose of these other sugars is to reduce the sweetness of honey and at the same time overcome the tendency of the levulose in the honey to absorb moisture and thus make the candy sticky when warm weather comes on. With these other sugars it is possible to make a greater variety of candies, those which will hold their shapes without coating or wrapping. These other sugars in connection with ground nuts make a very tempting variety and when honey is the chief ingredient so that the name honey can be honestly used, the product will sell.

D. C. Gilham, Schuylkill Haven, Pa., is a honey producer, who, like Mr. Starr, makes and sells honey candy using some other sugar. His product is very fine.

Mrs. Malitta F. Jensen, Secretary and Manager of the American Honey Institute, Madison, Wis., has done much through the organization to promote the sale of honey. A large number of honey recipes for honey in cooking and baking were worked out by her in food kitchens. She has made a special study of honey in connection with other foods and it is her opinion that a better and more tasty honey candy can be made by using another sugar along with the honey.

The Big Candy Companies

Before we turn to the recipes the reader may wish to know who of the large candy makers of national reputation are using honey in some of their candies. Most if not all of these products use another sugar along with honey. Sometimes they use corn sugar, sometimes they use cane sugar, either brown or white. These big companies, whether they use honey alone or in combination with another sugar, provide a wide outlet for honey. Beekeepers should encourage these people by boosting their products.

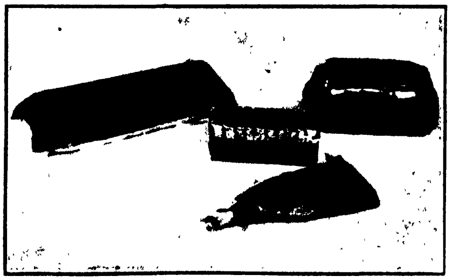
Natt N. Dodge, a correspondent for Gleanings in Bee Culture, who has interviewed some of the big companies making candy, writes in Gleanings, page 672, for 1932, as follows:

The decided trend away from home baking, candy-making, and the like which followed the war, and the assuming of these activities by commercial concerns opened many new possibilities for the use of honey. It has been only within the last year or two that commercial candy manufacturers (with one or two exceptions) with national distribution of their products have done much toward featuring honey in their confections and in their advertising. Numerous small concerns have attempted to use honey in candy making with questionable success. Failure in many cases was due to the peculiar ability of honey to absorb moisture from the atmosphere. Chocolates in which granulated honey was used as a center were not satisfactory in many cases because the centers, in absorbing moisture, caused the chocolate coating to crack and the candy to "weep." This very hygroscopic property of honey is the feature which makes its use so satisfactory in bakery products where an ability to retain moisture is particularly desirable.

The popularity of the five-cent candy bar has swept the country in the last half decade, and now we find several manufacturers of these favorite confections using considerable amounts of honey annually. The writer has queried several of these manufacturers in the belief that beekeepers are intensely interested in the uses to which their product is put, and in an effort to learn if the use of honey in their products has been of benefit to them. In other words, does the American public like candy made with honey?

A Popular Honey-Almond Confection

One of the five-cent confections which may be found through the length and breadth of the land is the Mars "Honey Almond Bar." Not only does this bar bring honey to the attention of millions of consumers daily, but full-page advertisements of Mars Confections have featured the "Honey Almond Bar" in several magazines of national circulation. In commenting on this candy, Mr. E. J. Forsburg of Mars, Incorporated, states :



Several commercial honey-made confections. The "Honey Fluff" bar, with its all honey center, failed to find popular acceptance. "Honey Almond" and "Honey Scotch" in the square and the "pop" forms, enjoy wide sale.

"Honey Almond is the newest Mars Confection. It has a center of beaten egg-whites, sugar and syrup flavored with the finest quality of pure extracted honey, and chock full of fresh, crisp, whole almonds. Honey Almond is

thickly coated with rich vanilla chocolate. We use about 10,000 pounds of honey each day in the production of this bar. This light-amber, alfalfa honey is screened and strained before it is added to the syrup, and cooked, and put into the nougat."

The Carleton Bar, manufactured by the Curtiss Candy Company of Chicago, makers of the famous Baby Ruth bar, is similar to the Honey Almond of the Mars Company. It is a chocolate coated bar with a nougat center containing nuts. It, also, is flavored with honey.

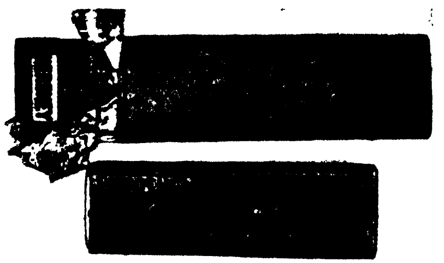
A Delicious Honey-Milk-Chocolate-Almond Candy

The Hershey Chocolate Corporation for many years has been known from coast to coast, for Hershey Chocolate Candy. The Hershey Bar was one of the first "five-centers" to be put on the market and has mantained an unusual popularity for an exceptionally long time. Recently the Hershey Corporation has commenced the manufacture of the Hershey Honeybar, regarding which Mr. William F. R. Murrie, President of the Hershey Chocolate Corporation, writes:

"In our Honeybar we use all the honey that we are able to put into it, but on account of the stickiness of honey, we have, of course, limitations. It has received, we are pleased to say, reasonable amount of acceptance from the consuming trade."

Honey Scotch and Honey Pop

For many years, the little plaid-clad girl of the J. N. Collins Company has been a familiar sight to the people of the United States, for Collins' Honey Scotch has been advertised in magazines, billboards, and in street cars



The Hershey's "Honeybar," a honey, milk chocolate, almond confection, made by the well-known Hershey Chocolate Corporation. This popular candy is now sold in the five-cent bar and the smaller two-for-five bar.

throughout the land. There are but few who are not familiar with the dainty squares of honey-colored caramel, each in its individual wrapper. Recently the Collins Company has started to manufacture and distribute the Honey Scotch Pop, a piece of candy of the all-day sucker type especially for children. Mr. Calvin K Kazanjian, President, has the following to say about Honey Scotch:

"We have used honey in Collins' Honey Scotch for over 15 years, during which period of time we have consumed many carloads of honey. While at the present time our consumption of honey is rather light due to the severe business depression we are going through, still we are hopeful we will again be consuming large quantities of honey when normal times return. Soon after the first of the year, we shall place a new 5-cent product on the market called 'Honey Bites,' which is a different type of candy, having a delicious white nougat center in soft caramel in which honey is used. We believe this product will greatly increase our use of honey. We have found that many people object to Honey Scotch due to the hard nature of the candy and their defective teeth. With 'Honey Bites,' this objection is removed, the confection being very soft.

"There are generally two reasons why candy makers use honey. The product has a quality and sales appeal, and at the same time acts as an invert sugar, assisting in keeping the other sugars from graining. As you know, honey is probably the oldest ingredient used in candy, the earliest forms of candy known being a combination of honey and figs, made centuries ago. Honey Scotch is nationally distributed, being on sale in every city, town and village throughout the United States. It is also manufactured and sold throughout Canada."

It is quite apparent from the letters of these leaders in the candy industry, that immense quantities of honey are consumed each year through the channel of the five-cent candy bar. and that possibilites for increasing the use of honey through this outlet are multiplying all the time. Up to the present it would seem that candy manufacturers have capitalized only upon the quality appeal of honey and that there remains a wonderful opportunity for increasing the popularity of honey-made candies through playing up the health values of honey and honey products. As the people of this country, through the efforts of the American Honey Institute, gradually become educated to the part which honey may play in the building and maintenance of health, candy, as well as many other products in which honey is used, should become increasingly popular.

Honey Candy Recipes

Most of the recipes here given call for some other sugar in varying proportions with honey. The purpose of this has already been explained. Any recipe that will use at least some honey helps to make an outlet for the beekeepers' product.

There are some recipes that call for twice as much of some other sugars as of honey. A satisfactory nougat, for example, can not be made without an excess of cane sugar. Again in other recipes, a brown sugar will do what neither a honey or granulated sugar will accomplish. Each of the sugars have their own special uses. It would be folly and only end in failure to make honey, an invert sugar, perform the function of a sucrose. Hence there will be a variation in the proportions in the different sugars.

Honey Fudge—¼ cup honey, 2 cups sugar, 1 cup evaporated milk, 1 square chocolate (cut fine), ¼ teaspoon salt, 1 cup nuts. Boil sugar, chocolate, salt and milk for 5 minutes. Add honey and cook to the soft ball stage (235° F.) Add butter. Let stand until likewarm Beat until creamy. Add nuts, pour on buttered pan, and when hard cut in squares.

Honey Divinity—⅓ cup honey, 2 cups sugar, ⅓ cup water, 2 egg whites, pinch salt, Boil together the sugar, honey and water until the syrup spins a thread when dropped from a spoon (about 250° F.). Pour the syrup over the well-beaten egg whites, beating continuously and until the mixture crystallizes. Drop in small pieces on waxed paper.

Honeyed Fruit Strips—Remove peel from 3 oranges and cut in strips. Cover with water to which 1 teaspoon of salt has been added. Boil 30 minutes and drain. Cover with fresh water and boil until the peel is tender. Drain. Pour enough honey over the peel to cover, usually

from ¾ to one cup. Let simmer very slowly until fruit peel is clear about 45 minutes. Lay on waxed paper and let stand two or three days before using.

Chop Suey Candy—Run dried fruits through food chopper, prunes or apricots (uncooked), dates, figs, raisins, dried peaches or pears. A good combination is ¼ cup prunes, ¼ cup apricots and ½ cup dates, or ¼ cup figs and ¼ cup raisins. Nuts may be added. Add just enough honey to hold together. Butter the hands and shape into balls. Roll in chopped nuts or cocoanut or dip in chocolate.

Honey Fruit Slices—3 to 4 tablespoons honey, ½ cup shredded cocoanut, ½ lb. dates stoned, ½ square chocolate, 2 cups All-Bran, ½ cup seedless raisins. Run cocoanut, raisins, and dates alternately through the food chopper. Add melted chocolate, bran and honey alternately. Form mixture into a roll. Cut in slices with sharp knife. Wrap in waxed paper and store in a tightly covered container.

Honey Fruit Balls—Toast a cup of shredded cocoanut in a moderate oven 350° F. until a delicate brown. Wash a cup of dried apricots and a cup of dried peaches and steam five minutes. Put fruits through the medium fine knife of the food chopper while they are hot; add a tablespoon of honey and the toasted cocoanut Blend thoroughly. Shape into small balls or into a round loaf and slice when chilled. Reserve some of the toasted cocoanut in which to roll the balls.

Honied Rice Krispies Balls—¾ cup sugar, ½ teaspoon salt, ½ cup water, ¾ cup honey, 2 packages Kellogg's Rice Krispies. Put sugar, salt and water into a saucepan and cook, stirring until the sugar is dissolved. Boil until a temperature of 300° is reached (very brittle). Add honey slowly, stirring until blended. Cook again until thermometer registers 240° F. (about one minute) Pour over Rice Krispies. While hot drop by spoonfuls into buttered cups or muffin tins or form into balls. Or press into buttered pans and when cool cut into bars. Yield: 16 balls or bars.

Caramels—Take 1 pint honey, 1 teaspoonful cinnamon or vanilla, ½ pound cocoa, ¾ pound pecan nuts, 2 pounds sweet almonds. Cut the nuts fine, and boil them with other ingredients until thick. Cool and roll out. Cut in squares and dry in the oven.

Caramels—One cup extracted honey of best flavor, 1 cup granulated sugar, 3 tablespoonfuls sweet cream or milk. Boil to "soft crack," or until it hardens when dropped into cold water, but not too brittle—just so it will form into a soft ball when taken in the fingers. Pour into a greased dish, stirring in a teaspoonful extract of vanilla just before taking off. Let it be ½ or ¾ inch deep in the dish; and as it cools cut in squares and wrap each square in paraffin paper, such as grocers wrap butter in. To make chocolate caramels, add to the foregoing one tablespoonful melted chocolate, just before taking off the stove, stirring it in well. For chocolate caramels it is not so important that the honey be of the best quality.

Peanut Honey Candy—Take 1 cup butter, 2 cups honey, 2 cups sugar, 1 cup boiling water, ¼ teaspoonful cream tartar, ½ teaspoonful glycerine, a tiny dash of soda. Boil ten minutes to a soft ball, and set in a cool place. When it has cooled slightly, stir in one or two tablespoonfuls of peanut butter, or to suit the taste; keep stirring till creamy; then pour into buttered pans; mark in squares.

Peanut Candy—Use 1 cup honey, 1 cup granulated sugar, 4 tablespoonfuls sweet cream. Boil until it cracks when dropped in cold water. Remove from the fire and stir in a pound of peanuts that have been previously shelled and well crushed with the rolling-pin. Pour into a greased pan and set to cool.

Peanut Rolls—Take 1 cup butter, 2 cups honey, 1 cup boiling water, ¼ teaspoonful cream tartar, ½ teaspoonful glycerine, a tiny dash of soda. Boil ten minutes; pour over a layer of rolled peanuts which have been scattered evenly over the bottom of the buttered pan. When nearly cold, mark off in long strips and roll up tight; then slice across with a sharp knife, before it gets quite cold.

Honey Chocolate—Chocolate sweetened with honey rather than with sugar is excellent. It is very easily made: Melt 1 pound of gelatine in a pint of water; add 10 pounds of honey thoroughly warming the same, then add 4 pounds of cocoa. Flavor with vanilla when taken off the fire. Pour into greased dishes or molds.

French Candies—In an enameled sauce-pan melt 1 part of gelatine in 1 part of water, stirring well. When at the state of a soft paste, add 4 parts of honey previously warmed, stirring lively. Take from the fire; add the desired flavor and color, mixing carefully, and pour into a shallow lightly greased dish. Let it dry for a few days.

Taffy—Use 3 cups sugar, ⅔ cup extracted honey, ⅔ cup hot water. Boil all together till it spins a thread when dropped from a spoon, or hardens when dropped into cold water. Pour into a greased vessel. When cool, pull until white.

Popcorn Balls—Take 1 pint extracted honey; put it into an iron frying-pan, and boil until very thick; then stir in freshly popped corn, and, when cold, dampen the hands in cold water and form into balls. These will especially delight the children.

Good Candy—Use 2½ cups sugar, ½ cup honey, ½ cup water. Boil until thick syrup. Pour one cupful of syrup on the beaten whites of 2 eggs, stirring meanwhile. Boil remainder of syrup till it hardens when dropped in water, then pour it into the syrup and eggs, stirring briskly. Add a cupful of peanuts. Stir until it begins to harden; then spread in a pan and cut in squares. Flavor to taste. If properly made it will be soft and pliable.

Honey Bittersweet—Let section of comb honey remain in refrigerator about 24 hours before using for coating. Then dip the knife to be used for cutting in boiling water. Cut comb honey into pieces about ¾ of an inch long and ⅜ inch wide. Place pieces on trays covered with waxed paper and chill for thirty minutes before coating. Be sure dipping chocolate is proper temperature and then coat honey pieces just as coating cream centers. Drop a walnut, pecan, or almond on each piece It requires practice to be able to turn out honeyed bittersweets that do not develop honey leaks. This is an unusually delicious and wholesome candy.

Honey Date Snow Balls—Stone ¾ pound of dates and put them through the food chopper alterntaely with ¾ cupful of shelled walnuts. Add 2 tablespoonfuls honey and ¼ teaspoonful salt. Shape into small balls about the size of butter balls. Roll in powdered sugar.

Honey Nougatines—⅓ cup honey, ⅓ cup pure corn syrup, paraffin (size of a pea), 1 cup sugar, ¼ teaspoon salt, ¼ cup water, 1 teaspoon vanilla, whites 2 eggs, ½ pound chocolate, 1 cup almond or walnut meats, chopped fine. Mix the honey, corn syrup (or glucose), sugar, paraffin, and water. Boil until a drop makes a hard ball when dropped into cold water (248° F.). Stir occasionally while boiling. Pour part of the syrup gradually on to the whites of the eggs, beaten dry. Add the salt. Beat constantly in pouring. Boil the remainder of the syrup until is is brittle when tested in cold water (290° F.), and again pour on the eggs, this time all of the syrup, and beat constantly while pouring. Then boil the mixture and beat constantly until it is crisp when tested. Cool in a buttered tin. Cut in oblong pieces and coat with chocolate.

Honey Fondant—2 cups granulated sugar, ½ cup water, ⅓ cup honey. Mix, put over fire, and stir only until the sugar is dissolved. Boil carefully until able to shape a very soft ball when tested in cold water (about 238° F.). Do

not stir while boiling and do not scrape off sugar which adheres to the side of the pan. When done, pour into greased platter and partially cool. Beat and stir with a wooden spoon until it begins to crumble and then knead with the hands like dough. Pack in a bowl, cover with cloth, and set aside until needed. When ready for use the bowl of fondant may be set in hot water until soft enough to handle. Any flavoring may be added when shaping into candies. The honey flavor alone is delicious when the fondant is used to stuff dates. The use of honey in fondant obviates the necessity of using cream of tartar. The slight acidity of the honey keeps it from gaining too soon. If the fondant is boiled too hard, pull until white; the result will be a fine taffy.

Nougat Montelimart—1 vanilla bean, 1 pound liquid glucose, 3 pounds blanched and slightly browned Valentia almonds, 3 pounds finely crushed sugar, ½ pint whites of eggs, 1 pound blanched and dried pistachio nuts, 2 pounds extracted honey. Place the sugar in a copper sugar boiler with ¾ pint of water and let it dissolve with a little heat. Strain through a fine hair sieve or "Tammy" into a basin. Rinse the sugar boiler, return the sugar to it, and in due course boil it with the vanilla bean up to 280° F. by the sugar thermometer. Place the honey and glucose in a copper egg bowl and stand them over the steam bath as described, and gradually melt them, stirring gently with a thin wide spatula. When quite hot and every trace of honey crystals gone, beat the whites into a very solid whip, and at once stir them into the hot honey and glucose and stirring all the time, dry the mixture over the bath. The length of time needed for this operation will depend upon the heat of the steam bath and the amount of moisture in both honey and whites. Nothing short of actual experience will tell the workman when the right stage is reached. It will probably be an hour, maybe longer. At the proper stage, boil up the dissolved sugar with the vanilla bean to 280° F., remove the bean and pour the hot sugar in a thin stream on the mixture, stirring all the time. For this you will need assistance, either for pouring or stirring. Continue reducing over the bath with constant stirring until the batch is sufficiently dried. Test it by taking out a small piece, dipping it into a pan of cold water, and judge of its consistency and non-stickiness. When the right reduction is reached, carefully and thoroughly stir in the nuts, blend carefully and pour into the prepared frames 1½ inches to 2 inches thick, spread quite level, cover with wafer paper, set on the top boards with the necessary weights, and leave for twelve hours before cutting into ¼-pound, ½-pound and 1 pound bars. With the object of saving time, it is the practice of some confectioners to boil the sugar up to 200°, or even 300° F., and add it without reducing or drying the honey meringue so much, but this does not give it so fine a color or leave the mass so cheesy in character.

Nougat for Centers—3 pounds finely crushed sugar, 1 pound liquid glucose, 2½ pounds blanched, filleted and dried Valentia almonds, ¾ pound blanched filleted and dried pistachio nuts, 1 vanilla bean, 2 pounds strained honey, ½ pint white of eggs. Make this nougat exactly as the Montelimart, but spread thinner as instructed.

Honey Chocolates—5 pounds sugar, 2½ pounds honey, 1½ pints of water. Cook to 240° F. Pour on a dampened slab. When lukewarm pour on the batch 2 pounds of ground pecans, then cream it in the usual way. Melt the cream, adding ½ pint glass of simple syrup. Run into starch prints the shape of patties. Dip in sweet chocolate.

Honey Caramels—4 pounds extracted honey, 2 pounds sugar, 6 pounds corn syrup, 2 gallons of cream. Cook to 242° or a medium ball, then slack back with a quart of cream and again cook to 242°. When this point is again reached, add another quart of cream and then bring up to a good stiff ball or 248° over a slow fire. Pour out on slab, and when cold, cut. Nut meats and fruit can be added to this piece if desired.

Honey Fudge—½ cup evaporated milk, ¼ cup honey, 1 cup brown sugar, 1 pinch soda, pinch of salt, 2 tablespoonfuls butter, 1 cup cane sugar, 1 square chocolate. Mix sugars, evaporated milk, and chocolate and salt together. Then add honey and pinch of soda. Cook until firm ball is formed when dropped in cold water. Remove from heat, and butter and beat vigorously until soft enough to form flat cakes when dropped from a spoon. Pour into buttered plate and when set cut into pieces two inches square.

Honey Candy—2 tablespoons honey, 1 teaspoon vanilla, 1 cup boiling water, 2 egg whites, 2 cups white sugar, 2 tablespoons butter. Dissolve honey in the boiling water. Add to sugar and butter. Boil until syrup forms a thread. Gradually pour boiling syrup over egg whites, beaten stiff, beating constantly. Beat until the mixture is cold. Drop by spoonfuls on oiled paper.

Honey Marshmallow Cream—Quarter cup honey, 1 teaspoon gelatine, ½ cup cold water, ½ cup boiling water, whites of 2 eggs, 1 teaspoon vanilla, 1 teaspoon lemon extract. Dissolve gelatine in usual way, heating over tea kettle until thoroughly dissolved. Cool, but do not chill; stir in the honey, and add to the whites of the eggs beaten very light, a few spoonfuls at a time, beating constantly. Divide into two parts; to one part add color and flavor with vanilla about 1 teaspoon. To the other part add 1 teaspoon lemon extract. Mold in suitable size.

Honey Stuffed Cherries—Large maraschino cherries may be stuffed with little pieces of comb honey and coated in the same manner as the dates. They make unusually juicy centers much enjoyed by those who like cherries.

Honey Stuffed Dates—Remove stones without marring the shape of dates. Fill the cavity with a tiny piece of comb honey and then dip dates as ordinarily when coating candy. After a week or two the dates seem to absorb most of the honey, and when one bites into the candy a most flavored date center is found. This candy should be aged at least two weeks before packing.

Honey Coating—3 cups walnut kernels, 1 cup of sugar, ⅛ cup honey, ¼ cup water. Boil sugar, water and honey to 240° F. if a candy thermometer is used to to a good soft ball. Add a little vanilla and a teaspoonful of butter at the time of removing from the fire if this flavor is desired. Stir until it begins to grain, then add nuts, stir around a bit, remove and cool on oiled paper.

Brown Coating.—In the above recipe simply add slightly more than 1.8 cups of sweetened powdered chocolate. Stir until the coating has creamed and hardened on the nuts, then separate the nuts and cool on oiled paper or a plate.

Honey Nut Bon Bons—1 cup nut meats, 1 tablespoon candied honey creamed in a warm bowl—give a light stir, set in a cool place for a short time and use as a filling for dates. To serve as confections I have added cocoanut, but prefer this recipe.

Honey Crisp—1 cupful shelled walnut meats, 2 cupfuls honey. Break or chop the nuts into small pieces and spread them in a medium-sized dripping pan which has been well oiled with butter or salad oil. Put the honey into a saucepan, place it over a gentle heat and let boil for five minutes after it reaches boiling point, stirring occasionally while cooking. Pour over the nuts, set aside to become hard, then crack the crisp into convenient-sized pieces for serving.

Honey Toffee—4 ounces sugar, 2 ounces honey, 2 ounces butter. Melt the honey and sugar together in pan, and cook slowly for fifteen minutes, then add the butter, and cook for another five minutes. Try in a cup of cold water about ten drops of toffee, and if it sets, it is done; turn into a lightly buttered tin pie

plate scatter nuts over top and let set. Break into small pieces by hitting plate on the bottom.

An Uncooked Confection—Toast a cup of shredded cocoanut in a moderate over (350° F.) until a delicate brown. Wash a cup of dried apricots and cup of dried peaches and steam five minutes. Put fruits through the medium fine cutter of the food chopper while they are hot; to them add a tablespoonful of honey and the toasted cocoanut and blend thoroughly. Shape into small balls or into a round loaf and slice when chilled. Reserve some of the toasted cocoanut in which to roll the finished balls or slices.

HONEY COLORS.—The various kinds of honey differ very much in color, flavor, and density. One source may be practically colorless, while another produced in the same locality, under the same conditions, by the same bees, but from different flowers, may be a dark brown. One kind may contain less than 17 per cent of water, while another may contain 25 per cent.

The best honeys of this country are usually spoken of as "water-white," and, though this is not quite correct, still it is near enough for all practical purposes without coining a new word.

Clover honey may be taken as the typical white honey by which others may be conveniently judged. For the purpose of comparison some may be a little lighter, and others a little darker shade; but these nice distinctions are visible only to experts.

Taken by this standard, in the North there are all the clovers—white, alfalfa,* crimson, mammoth, alsike, sweet clover—and the European sainfoin; basswood, raspberry (wild), willow-herb (or fireweed), milkweed, Canada thistle, apple, cucumber (pickle), and Rocky Mountain bee plant. In the South white honey is obtained from the following: Gallberry, sourwood, tupelo, mangrove, cotton, palmetto, bean, huajilla, catsclaw, huisache, mesquite, California sage, orange, and some others of less importance. In the American tropics the chief white honey is from logwood or campeche; on all tropical seashores (Florida), campanilla (Cuba) and the mangrove.

Amber-colored honey comes from many sources. Among them only the more familiar ones can be noted in a popular book of this kind; namely, goldenrod, wild sumac, poplar, gum, eucalyptus, magnolia, marigold, horsemint, horehound, carpet-grass, and the hog plum (hobo), rose-apple, and royal palm of the West Indies.

Of dark honeys there are two great examples — the buckwheat of the United States and Europe, and heather, which is confined to Europe alone. The latter, though dark, is a rich, strong-flavored, thick honey, so dense that the extractor is not used to take it from the combs. That produced in Scotland commands a very high price, while that of England is cheaper, being gathered from another species of heather. In North Germany the heath or heather honey commands a good figure. It is largely produced by migratory beekeepers, their bees existing on white clover during summer, and in the fall being moved to the heaths.

Buckwheat, or dark honey, is highly prized where produced, but is usually not popular elsewhere, but it is so liberally produced in buckwheat localities that it is a paying crop to the beekeeper. It blooms late, hence the bees can be prepared in ample time to profit by its bloom. This feature alone makes it very valuable to the beekeeper who is fortunate enough to live in a buckwheat-growing section. In those parts of the country where buckwheat is grown largely, consumers are willing to pay as much as they will for fine white honey. Indeed, many prize it more highly.

In France there is a great demand for buckwheat honey from bakers of a kind of bread which has been made for centuries. No other sort of honey is desired by these bakers, who derive nearly all their supply from Brittany, where buckwheat is commonly sown. Attempts have been made to get the bakers to use other dark honeys, but without success.

In Europe there are some prominent honeys which are almost or quite unknown in this country. Heather has been mentioned. Sainfoin is another which is quite common, being almost the same as our alfalfa honey. Narbonne honey belongs to this class. In southern Europe romarin (rosemary) is very highly spoken of; and in Greece there is the classically famous honey of Mount Hymettus from wild thyme. In Australia the honey of eucalyptus is highly appreciated. In California, eucalyptus has a limited demand.

HONEYCOMB.—A beautiful thing in nature is a piece of comb honey with its snowy whiteness and its burden of sweetness. Aside from its whiteness and sweet-

*This is a light amber in southern California and Arizona.

ness, the marvelous structure of the comb compels our admiration. The walls of its cells are so thin that from 3,000 to 4,000 of them must be laid one upon another to make an inch in thickness, each wall so fragile as to crumble at a touch, and yet so constructed that tons of honey stored in them are transported in safety thousands of miles.

Formerly the word "honeycomb" meant both the comb and the honey contained in it; in other words, what we now call "comb honey" was called "honeycomb." Wherever the word "honeycomb" is found in the Bible, it means "comb honey."

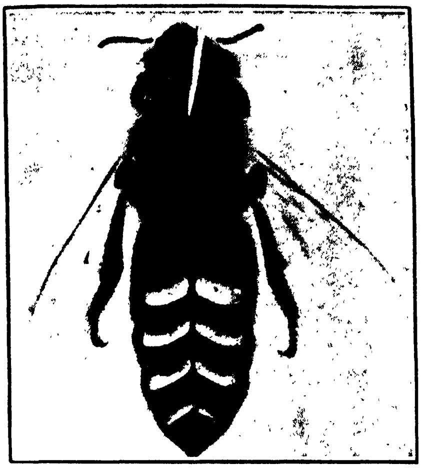
It is only in comparatively recent years that the real source of the wax of which comb is constructed has been known. In 1684 Martin John discovered that with the point of a needie he could pick scales of real beeswax from the abdomen of a bee working at comb-building.

Wax scale.

Jaw of a worker-bee.

These wax scales may be found plentifully on the floor of a hive at a time when much comb-building is going on. They are somewhat pear-shaped, as shown above, where is shown also the powerful jaw of the worker by which the wax is worked. These wax scales are much more brittle than the wax that has been worked into comb, and are transparent, looking somewhat like mica. Some say they are white, some say pale yellow. Probably enough, both are right, the color depending upon the pollen consumed.

These wax scales are secreted by eight wax-glands on the under side of the abdomen of the worker bee, as seen in cut, next column.* Examine a swarm lately hived, and plenty of bees will be found showing this appearance. When first secreted, wax is liquid. It is derived from the blood of the bee by cell action. So it is an expensive product, and one might well say it is derived from the "sweat and blood" of the bee, for it is sweat out from the blood by the wax-glands. Just how expensive it is seems a hard matter to learn. For many years the stereotyped expression was, "Every pound of wax requires 20 pounds of honey for its production." Later investigations have cut down that estimate greatly. But there is no agreement. Some estimate as low as 3 or 4 pounds of honey to one of wax. Others say 7, 15, or some other number.



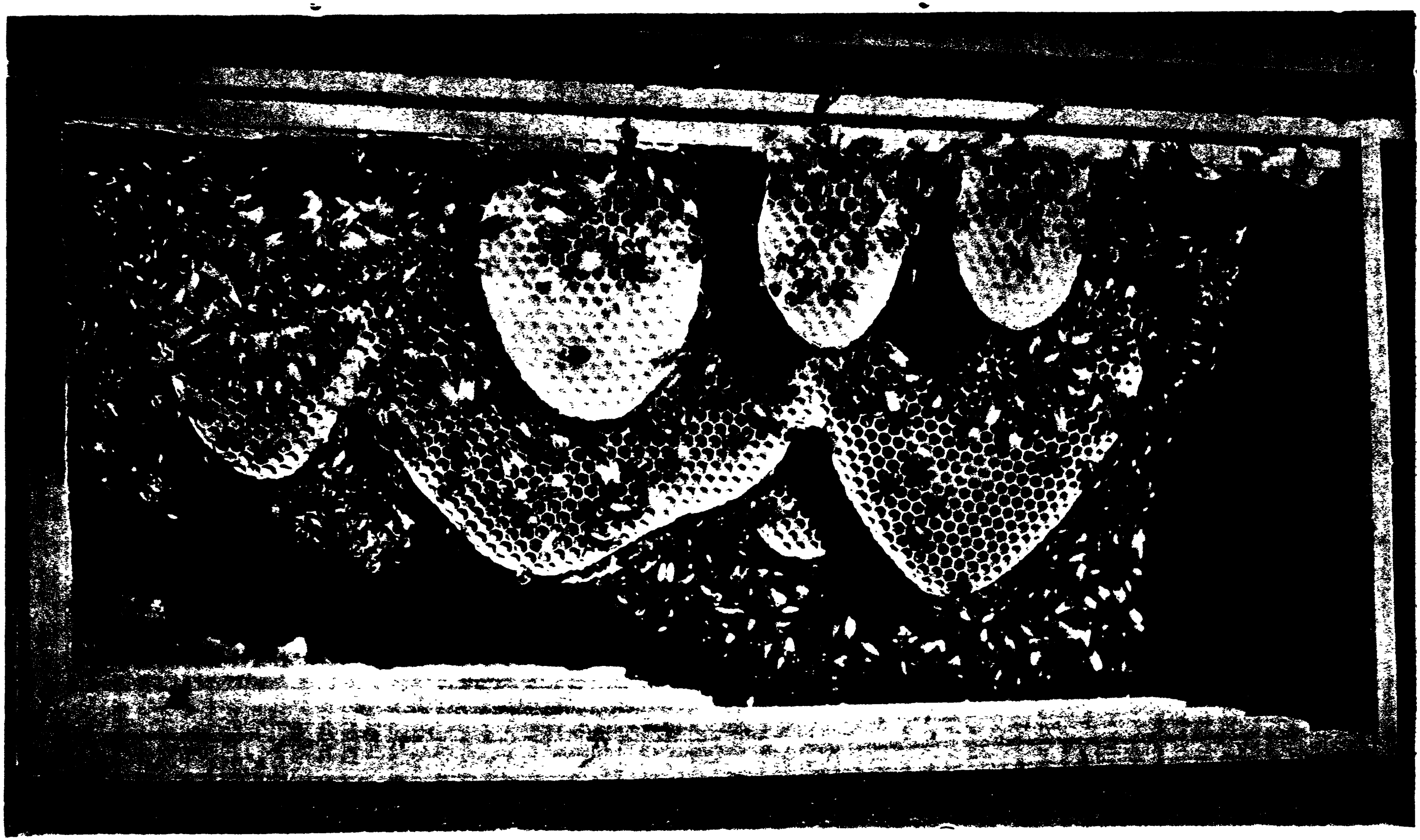
New wax secreted by wax glands appear as scales on the bee's abdomen.

Some hold that the secretion of wax is involuntary, nad that, if not utilized, there will be so much dead waste, and so nothing can be gained by trying to save the bees the work of wax secretion. But this is not the general view. Cowan says, in his book, "The Honeybee," page 171, "Wax is not produced at all times, but its secretion is voluntary." The practically unanimous agreement among beekeepers, that a very much larger quantity of extracted than of comb honey can be obtained, is hard to explain without admitting that the furnishing of drawn combs saves the bees much labor in the way of wax-production, and that production depends on conditions that come largely under the control of the beekeeper.

A high temperature favors the secretion of wax, and when it is produced in large quantities the bees hang inactively in clusters or festoons.

"Wax is not chemically a fat or glyceride," says Cheshire, in "Bees and Bee-keeping," Vol. I., page 160, "hence those who have called it 'the fat of bees' have grossly erred; yet it is nearly allied to the fats in atomic constitution, and the physiological conditions favoring the formation of one are curiously similar to those aiding in the production of the

*For a description of how these are removed by the bees, see Wax.



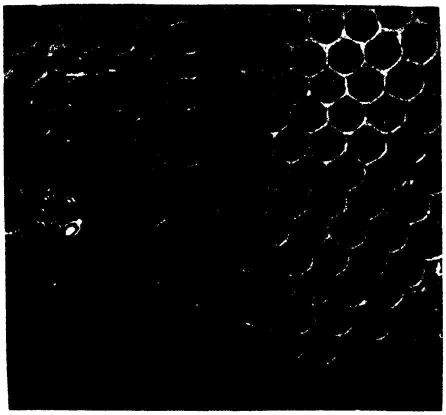
Natural-comb building, illustrating how the several pieces of comb are joined together. Photographed by W. Z. Hutchinson.

other. We put our poultry up to fatten in confinement, with partial light.. Our bees, under Nature's teaching, put themselves up to yield wax under conditions so parallel that the suitability of the fatting-coop is vindicated.

"The wax having been secreted, a single bee starts the first comb by attaching to the roof little masses of the plastic material, into which her scales are converted by prolonged chewing with secretion; others follow her example, and the processes of scooping and thining commence, the parts removed being always added to the edge of the work, so that, in the darkness, and between the bees, grows downward that wonderful combination of lightness and strength, grace and utility, which has so long provoked the wonder and awakened the speculation of the philosopher, the naturalist, and the mathematician."

A chief use for the honeycomb being to furnish cradles for the baby bees during their brood stage, the problem is to find what arrangement will accommodate them in the least space and with the least expenditure of wax. If a number of cylinders with rounding bottoms be piled, and just back of them, back to back, and, as closely as they can be packed, another series of cylinders piled, there will be an arrangement that will leave a great waste of room between the lines of contact of those cylinders, and another waste between the points of contact of the rounding bottoms. If pressure be exerted on these cylinders so that the sides and bottoms come into contact, there will be cells that are six-sided, with bottoms that are made of three lozenge-shaped plates, or what, as a whole, is an exact counterpart of honeycomb. Some have argued that bees make the cells cylindrical in the first place, and then, by pressure from within, force the cells into the forms of hexagons; but, unfortunately for this theory, plaster casts, of which cross-sections have been made of combs in all stages of construction, show that bees *start* their work by making true hexagons and not circles or cylinders. This can be seen by looking through a piece of glass on which combs have been built. However the combs are made, their general construction is such that the greatest economy of space and material is effected for holding either brood or honey. There would be an equal saving of wax if the cells could be made square with flat bottoms; but such cells would not fit the young bees, nor would the comb be as strong. The hexagonal is the very best form of construction.

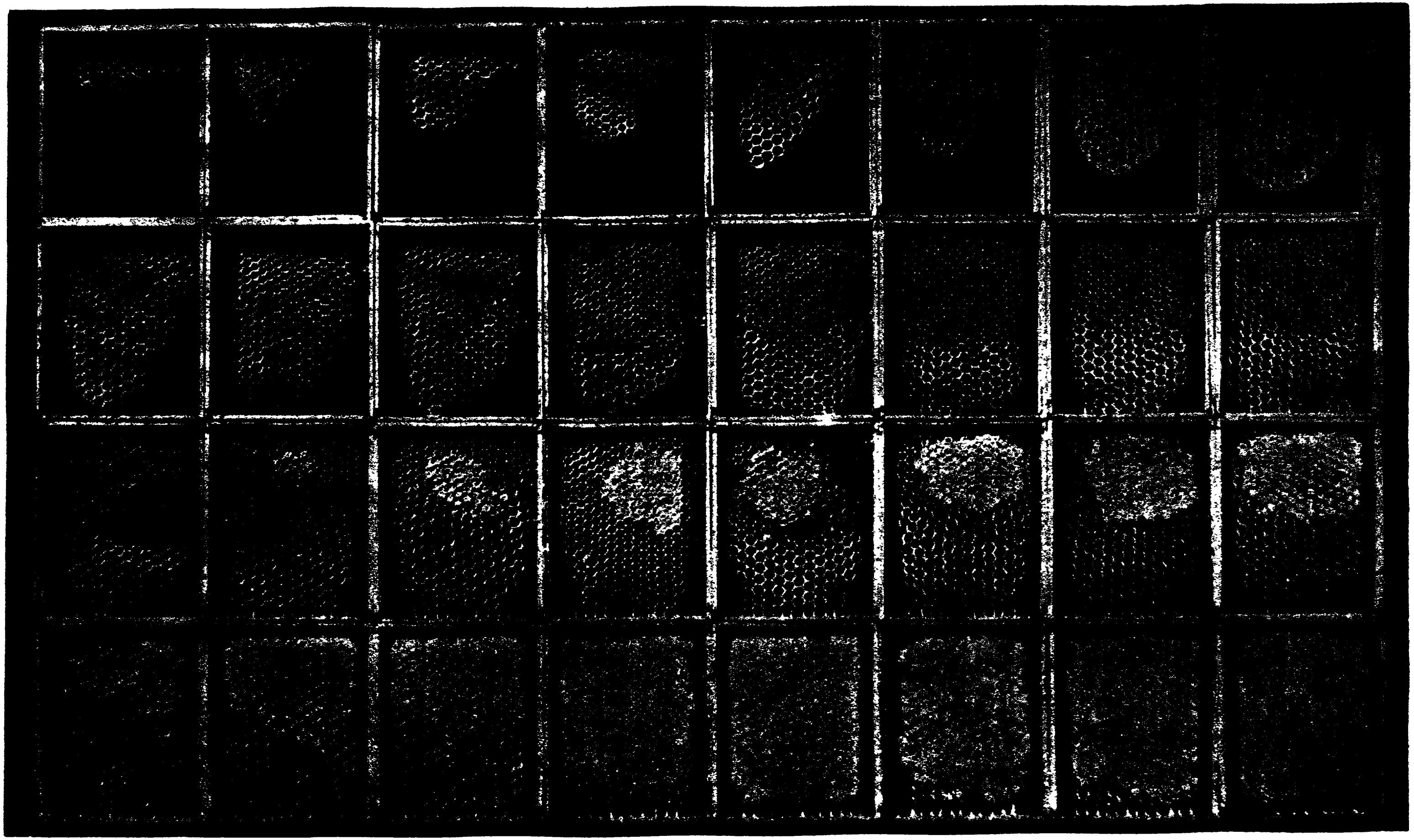
By far the larger portion of the cells in a hive will be found to measure about five to the inch. These are called worker-cells, and may be used for rearing worker-brood, or for storing honey or pollen. A smaller number of cells will be found to measure about four to the inch. These are called drone-cells, and may be used for rearing drone brood, or for storing honey—seldom for pollen.



How combs are attached to a vertical support.

If the worker-cells were exact hexagons measuring five to the inch there would be exactly 28 13-15 cells to the square inch on one side of a comb. But there is not this exactness, as will be shown by careful measurement, although the eye may detect no variation. Count the number of cells in a given length in a horizontal row of cells and then make the same count in one of the diagonal rows, and it will be found that they are not precisely the same. That shows that the cells are not exact hexagons. Measure the cells in a number of combs built by different colonies, or even by the same colony, and it will be found that they are by no means all of them five to the inch.

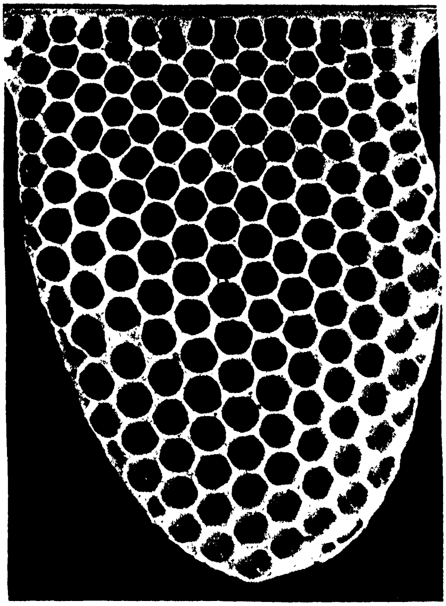
This, of course, refers to natural comb built by the bees without any comb foundation being supplied to them. Comb foundation is generally made with cells of such size that worker comb built upon it



The development or evolution of comb honey. These sections were selected from two supers of 32 sections.

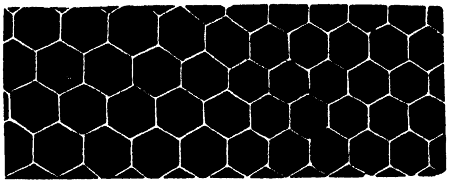
contains about 27 cells to the square inch.

Instead of lessening our admiration, the slight variation from exactness in the work of comb-building, when the bees are left free to take their own course, rather increases it, just as a piece of "hand-made" work is often more admired than that which is "machine-made." The marvelous ingenuity displayed in adjusting the work to varying circumstances is something far beyond machine-like exactness. Cut a few square inches of comb out of the middle of a frame of worker comb in the middle of a good honey flow, and the chances are that the bees will fill the hole with drone combs. A few cells will be built that are neither drone-cells nor worker-cells, and these are called **accommodation** cells; but so skillfully are the adjustments made in passing from worker to drone cells that at a hasty



A characteristic spur of natural comb built from a horizontal support.

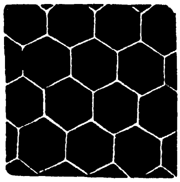
glance one would be inclined to say that all were either worker or drone cells. Observe the small pieces of comb started at different points on same top-bar on previous page. They may be at such distances apart that, when the two combs meet, if built with rigid exactness, the center of a cell in one comb will coincide with the edge of a cell in the other comb. Yet so skillfully are measurements made, and so gradual the change as one comb approaches the other, that the unaided eye can detect no variation from an unbroken



The merging of drone to worker comb.

comb of worker-cells. The whole is such an exquisite piece of work as no human expert can hope to equal. Besides the worker and drone-cells, queen-cells are built at times, as described.

In general, comb is built so that an angle is at the top and bottom of each cell,



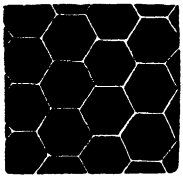


Fig. 1. **Fig. 2.**

as in Fig. 1; and this is believed to give greater strength than if the cells were built like Fig. 2.

When combs are built upon foundation, the rows of cells run in a horizontal line with exactness. But when the bees build at their own sweet will, there is no little variation from the horizontal.

While the cell-walls vary from 3-1000 to 2-1000 inch in thickness, the septum is thinner, sometimes being as thin as 1-1000 of an inch when first built. But as successive generations of young bees are reared in the cells, cocoons and secretions are left at the bottom of each, and in time the septum may become ⅛ inch thick. From this it happens that, although worker comb is ⅞ thick when first built, specimens of old comb may be found measuring an inch in thickness since the bees draw out the cell-walls at the mouth of the cell to balance the additions made at the bottom of the cell, so as to maintain the same depth in an old cell as in a new one.

When, however, worker cells are used for storing honey, if there be room for it the depth of the cells may be so increased

that the comb may be two or three inches thick. Drone comb is even more likely to be thus built out. The cells of both kinds slant upward from the center to the ex-

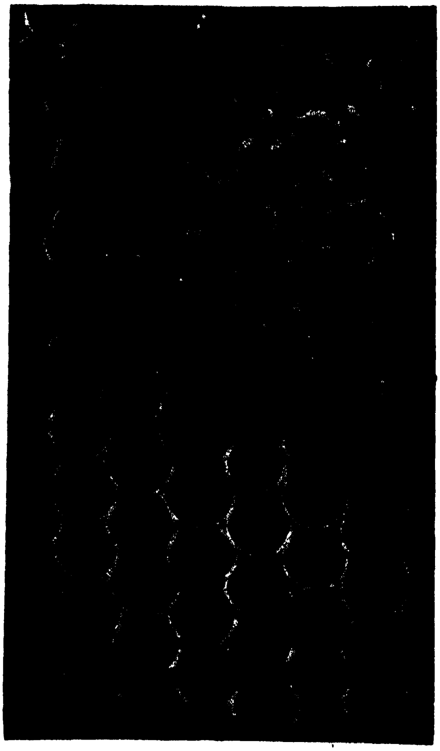
Cross-section of honey-comb, enlarged view. The cells are partly filled with honey. This illustration shows that the cells are not straight and horizontal, but curved and slanting upward.

terior of the comb, yet so slightly that to the casual observer they appear entirely horizontal. Yet when the comb is so greatly thickened for the storing of honey, the slant may be much increased, giving the cell a curved appearance.

Formerly it was thought that the cappings placed over honey are air-tight, and this in spite of the fact that it is a common thing to see white comb honey become watery and dark when kept in a damp place, the thin honey finally oozing out through the cappings. Cheshire, who at one time held that the sealing of honey-cells is air-tight, says (Bees and Beekeeping, Vol. I., page 174), "By experiments and a microscopic examination, I have made evident that former ideas were inaccurate, and that not more than 10 per cent at most of the sealing of honey is absolutely impervious to air." The sealing of brood-cells, however, is very much more porous (see Brood and Brood-rearing), which allows sufficient air for the brood. The brood-cell cappings seem to be made up of shreds of cocoons, pollen, and almost anything that comes handy, with only enough wax to weld the whole together.

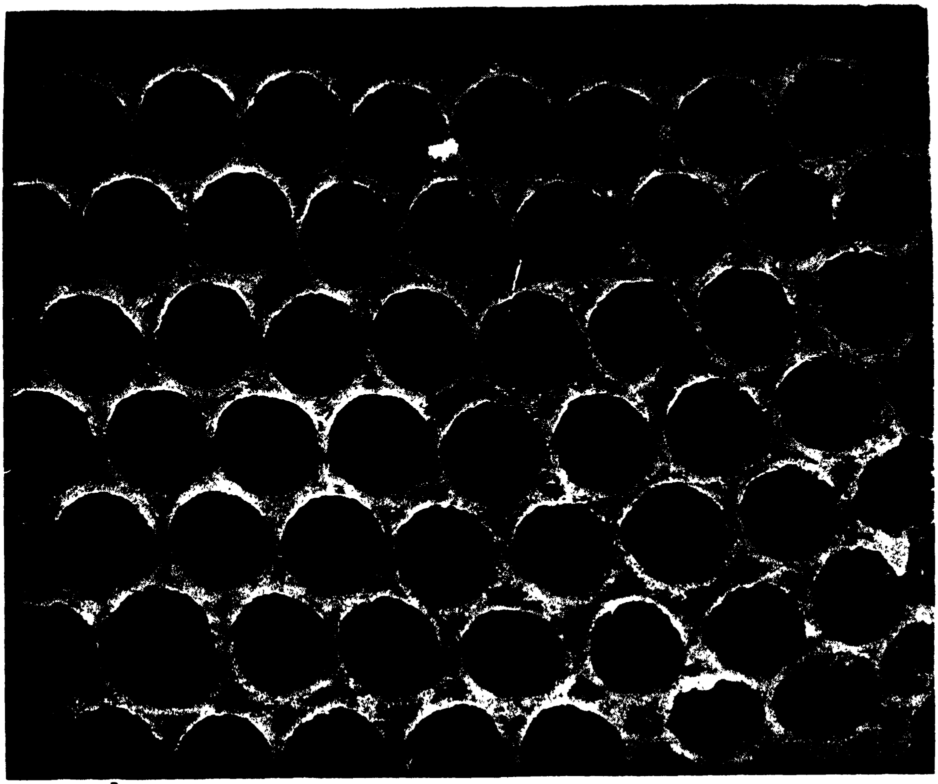
The beautiful white color of honeycomb becomes dark with age, and when used for brood-rearing becomes nearly black.

While drone comb measures just about four cells to the inch, the bees seem less particular about the size of it than that



Drone-cells used for honey storage. It will be seen that the lower part of the opening is capped first. This, with the slant of the cells, keeps the new honey from running out.

of worker comb. They often seem to make the cells of such size as to fill out best a given space; and, accordingly, the cells differ from worker size all the way up to considerably more than ¼ of an inch in width. Drones are raised in these extra-

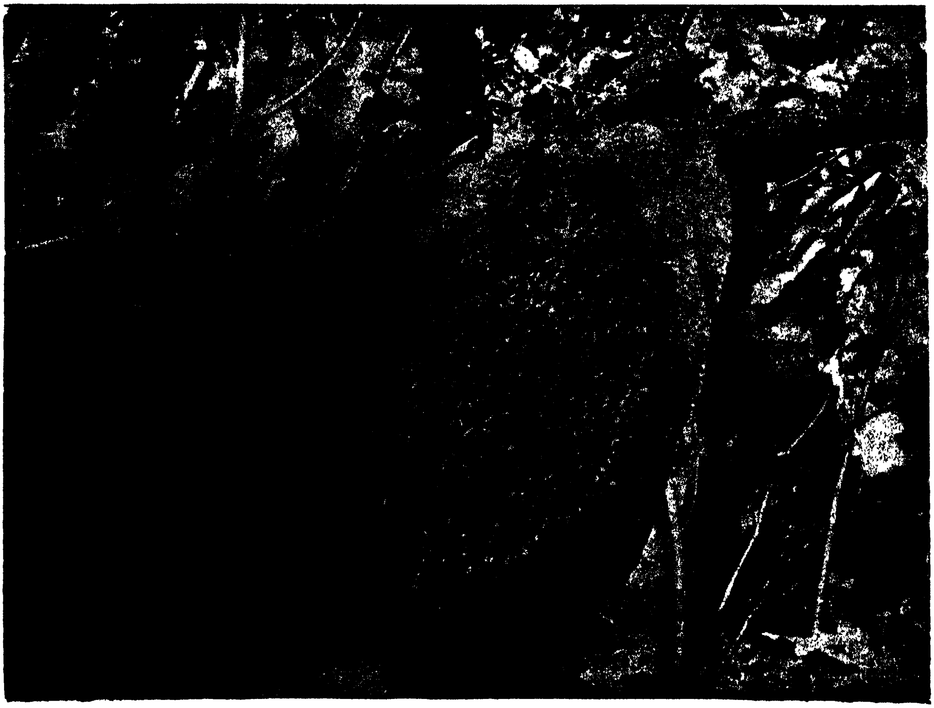


Top view of honeycomb greatly enlarged, showing the thick circular rim or coping at top of cell.

large cells without trouble, and honey is also stored in them; but where they are very large the bees are compelled to turn them up, or the honey would flow out. As honey is kept in place by capillary attraction, when cells exceed a certain size the adhesion of the liquid to the wax walls is insufficient, of itself, to hold the honey in place. Where drones are to be reared in these very large cells the bees contract the mouth by a thick rim. As an experiment, some plates were made for producing small sheets of foundation, having only 3½ cells to the inch. The bees worked on a few of these with these same thick rims, but they evidently did not like them, for they tried to make worker-cells of some of them, and it proved so much of a complication for them that they finally abandoned the whole piece of comb, apparently in disgust. Bees sometimes rear worker brood in drone comb, where compelled to by want of room, and they always do it in the way already mentioned, by contracting the mouth of the cells and leaving the young bee a rather large berth in which to grow and develop. Drones are sometimes reared in worker cells also, but they are so much cramped in growth that they seldom look like fully developed drones. (See Laying Workers; also Brood and Brood-rearing.)

Several times it has been suggested that the size of honeybees could be increased by giving them larger cells; and some circumstances seem to indicate that something may be done in this direction, although there is little hope of any permanent enlargement in size without combining with it the idea of selecting the largest bees from which to propagate. By making the cells smaller than ordinary, small bees are obtained with very little trouble; and the author has seen a whole nucleus of bees so small as to be really laughable, just because the comb they emerged from was set at an angle so that one side was concave and the other convex. The small bees came from the concave side. Their light, active moments,

Natural-comb building in a hive made entirely of glass.



Bees living on combs built in the open air.

as they sported in front of the hive, made them a pretty and amusing sight for those fond of curiosities. Worker bees reared in drone-cells are sometimes extra large in size; but as to whether they can be made permanently larger by such a course is very doubtful. The difficulty, where there is only natural-built comb, is the tendency to rear a great quantity of useless drones. By having a hive furnished entirely with worker comb built from worker comb foundation it is possible to restrict the rearing of drones to a comparatively small number. A few cells near the bottom or corners of a frame are sometimes reconstructed into drone comb. (See large illustration under Brood and Brood-rearing, page 111.)

How Bees Build Comb

In this day and age of bees and honey it would seem that one should be able to describe how bees build comb, with almost as much ease as one would tell how cows and horses eat grass; but for all that, records are lacking of careful and close experiments, such as Darwin made many years ago. In the author's house-apiary there were dozens of hives where the bees were building right up close to the glass; and all one had to do, in order to see how it was done, was to take a chair and sit down before them. But the little fellows have such a queer sleight-of-hand way of doing the work that one hardly knows how they do accomplish it.

If one will examine the bees closely during the season of comb building he will see on the under side of the body of the workers little scales protruding from the segments. These, Casteel* explains, are removed by the spines of the pollen comb of the third pair of legs and are then transferred to the fore legs. Sometimes in the process the wax scales drop down between the combs on to the bottom board where they can be seen with the marks of the pollen spines.

If a bee is obliged to carry one of these wax scales but a short distance, it takes it in its mandibles, and looks as business-like with it thus as a carpenter with a board on his shoulder. If it has to carry it a distance it takes it in a way that it is difficult to explain any better than to say it slips it under its chin. When thus equipped, one would never know it was encumbered with anything, unless it chances to slip out, when it will very dextrously tuck it back with one of its fore feet. The little plate of wax is so warm from being kept under its chin as to be quite soft when it gets back; and as it takes it out, and gives it a pinch against the comb where the buliding is going on, one would think it might stop a while, and put it into place; but not that bee; for off it scampers and twists around so many different ways one might think it was not one of the working kind at all. Another follows after it sooner or later, and gives the wax a pinch, or a little scraping and burnishing with its polished mandibles, then another, and so on; and the sum total of all these maneuvers is, that the combs seem almost to grow out of nothing; but no one bee ever makes a cell.

The finished comb is the result of the united efforts of the moving, restless mass; and the great mystery is, that anything so wonderful can ever result at all from such a mixed-up, skipping-about way of working as they seem to have. When the cells are built out only part way they are filled with honey or eggs, and the length is increased later on. It may be that they find it easier working with shallow walls about the cells, for they can take care of the brood much easier, and put in the honey easier, too, in all probability; and, as a thick rim or coping is always left around the upper edge of the cell (see page 420), no matter what its depth, they have the material at hand to lengthen it. This thick rim is also very necessary to give the bees a secure foothold, for the sides of the cells are so thin they would be very apt to break down with even the light weight of a bee. When honey is coming in rapidly, and the bees are crowded for room to store it, their eagerness is so plainly apparent, as they push the work along, that they seem to fairly quiver with excitement; but for all that they skip about from one cell to another in the same way, no one bee working in the same spot to exceed a minute or two at the very outside. Quite frequently, after one has bent a piece of wax a certain way, the next tips it in the opposite direction, and so on until completion; but after all have given it a twist and a pull, it is found in pretty nearly the right spot. As nearly as the author can discover they moisten

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*See Circular No. 161, Bureau of Entomology, Washington, D. C., by D. B. Casteel.

the thin ribbons of wax with some sort of fluid or saliva. As the bee always preserves the thick rib or rim of wax at the top of the cell it is working, the looker-on would suppose it was making the walls of considerable thickness (page 420); but if it be cut away, and this rim be broken, its mandibles will have come so nearly together that the wax between them, beyond the rim, is almost as thin as tissue paper. In building natural comb, of course the bottoms of the cells are thinned in the same way, as the work goes along, before any side walls are made at all.

When no foundation is furnished, little patches of comb are started at different points, as shown on page 417. As these patches enlarge, their edges are united so perfectly that it is sometimes difficult, when the frame is filled solid, to determine where the pieces were united, so perfect is the work. At other times there may be a row of irregular or drone cells along the line of the union.

The midrib of natural comb becomes thicker as it approaches the line of support and tapers toward the bottom. Why this is so is evident. It seems wonderful that there should be a gradual gradation in thickness from top to bottom in spite of the haphazard, skip-about work on the part of so many different bees.

For the consideration of the thickness of combs and how far to space them apart, see Frames, Self-spacing; also Spacing Frames and Comb Foundation.

No Artificial Comb Honey

Some persons who are foolish enough believe there is a honeycomb made from wood pulp, punk, putty, paraffin, or some material other than wax. Why foolish? Because a wise man changes his mind when it becomes necessary; but a fool, never. It would not be surprising in these days of sensational journalism and of false nature-stories if one should get the notion that artificial comb honey really exists; but the foolish part comes in when a person, totally inexperienced with bees, stoutly and smilingly maintain that there is such a thing as manufactured honey in the comb. The inimitably foolish expression of such a person is, perhaps, the origin of the colloquialism, "The smile that won't come off." No use. Do not argue. It won't come. "Why, I've seen it at the stores. Grocer told me all about it—was several cents cheaper. I tried it; we didn't like it as well as the genuine." And then the beekeeper goes away, not a wiser but a madder man, and wonders why the fool-killer doesn't do his duty, and why every one except the beekeeper knows all about bees and their products. (See Comb Honey, also Honey Exhibits.)

HONEYCOMB, MATHEMATICS OF.—Maurice Maeterlinck, in his book, "The Life of the Bee," records the fact that

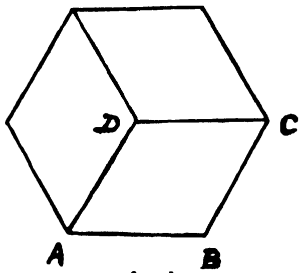


Fig. 1

The three rhombs which form the base of the cell in the honeycomb.

Reaumur, early in the eighteenth century, suggested the following problem to the celebrated Swiss mathematician Koenig: "What would be the size of the larger angle of the rhombs at the base of the bee's cell, if it were so built that it would use the least amount of wax to contain a given amount of honey."

The word rhomb is the correct name for the three lozenge-shaped figures at the base of a cell, as shown in Fig. 1.

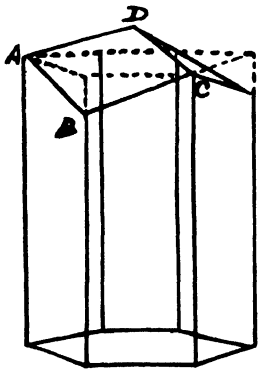


Fig. 2

The angle at B or angle ADC, which is its equal, is the angle which has greatly interested mathematicians during the past.

The rhombs are also shown in perspective in Fig. 2, which represents a transparent cell, the dotted line representing a flat-ended hexagonal prism of the same capacity as the cell; the thin lines would be invisible if the cell were opaque. The angle that Koenig was asked to find the size of is ABC, or ADC, which are equal.

Koenig answered that the angle was 109°, 26′; this he had found by means of the calculus, and he said the problem would have been insoluble to the ancients, as the calculus was unknown to them.

Another savant, Maraldi, had measured as exactly as possible the angles of the rhombs constructed by the bees and found that the larger one measured 109°, 28′. Between these two results there is a difference of only 2′, which is an almost invisible angle, it is so small. However, it was not the bees who had departed from the most economical shape; for Professor Maclaurin of Edinburgh, in a paper contributed to the Royal Society in 1743, showed how it might have been solved geometrically by the ancients, and found the angle to be 109°, 28′ 16″. Colonel I. F. Forbes of the British army recently calculated the angle and found it to be 109°, 28′, 16.349″.

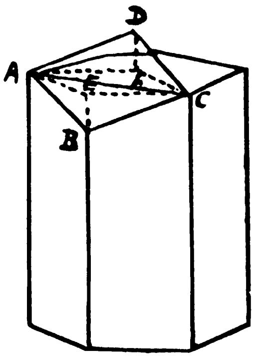


Fig. 3

Pyramid ABCE, cut off the hexagonal prism by the rhomb, is equal to pyramid ACDE, which is added to the prism; but less wax is needed for this construction than for a prism with a flat base.

In Fig. 3 is shown a square-ended hexagonal prism, with one of the rhombs ABCD, similar to those of a bee's cell, in position. B is the point at one of the corners of the prism, so that the angle ABC is 109°, 28′, 16″. A plane is cut through this point B, and the line AC up to the point D, which is on the axis of the hexagonal prism. We now see that the pyramid, ABCE, which is cut off the hexagonal prism by the rhomb, ABCD, is equal to the pyramid, ACDF, which is added to the prism. It follows, therefore, that the bee's cells hold exactly as much honey as if it consisted of a hexagonal prism, with a flat end, passing through AECF, but with this interesting difference, that the bee's cell has less surface than the flat-ended prism, and takes the least possible amount of wax to hold a given quantity of honey.

If you shift the point B up or down the corner of the prism, the cell formed would still contain the same amount of honey, but it would take more wax to make it if the angle ABC is not as stated above.

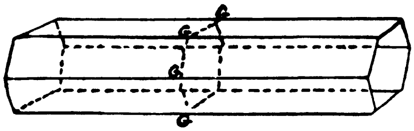


Fig. 4

A flat base between the cells on the opposite sides would not only require more wax to build cells holding any given amount of honey, but would also be a weaker construction than that used by the bees.

One would suppose that if the bees had built their cells exactly back to back, as shown in Fig. 4, a flat division wall, GG, would have divided the two cells with the least consumption of wax. One naturally thinks that a flat division wall must be more economical of wax than an indented one such as the bees employ, but it is not so.

The bees have adopted the most economical method, and the strongest, because the base of the cell is greatly strengthened by being buttressed by the ends of three cell walls on the other side of the base.

Was this construction of the comb cell thought out by some female Archimedes among the ancient honeybees, when they drew away from the less organized families of Anthophila? Did she rush up to the queen shouting, "Eureka, I have discovered it?" The intelligence of the hive is so great, we would like to believe that the form of the cell was due to the brilliant working of bees' brains; but we reluctantly think it more likely due

to blind obedience to divine guidance.—W. B. Wallace, Canterbury, England.

HONEY, COLLOIDS IN.—See Colloids in Honey.

HONEY, COOKING VALUE OF.—Before the use of honey in the home is taken up, comparative caloric values of sugars and syrups should be considered. These figures are taken from "Feeding the Family," by Mary Schwartz Rose, Department of Nutrition, Teachers College, Columbia University.

	100 Calorie portion measure.	Wt. oz.	Distribution of Calories, Fat, Protein.	Carbo-drate.
Corn Syrup	1¾ tblspns	1.5	..	100
Honey	1 tblspn	1.1	1	99
Maple sugar	4 tblspns	1.1	..	100
Maple syrup	1½ tblspns	1.2	..	100
Molasses	1½ tblspns	1.2	3	97
Sugar (wh. gr.)	2 tblspns	0.9	..	100
" white loaf	3½ lumps	0.9	..	100
" wh. powd	2 tblspns	0.9	..	100
" brown	2 tblspns	0.9	..	100

In other words, 1 tablespoon of honey based on caloric value is equal to 1¾ tablespoons corn syrup, 4 tablespoons maple sugar, 1½ tablespoons molasses, etc. The above chart just concerns the calories within given portions of various types of sugars. Honey has about 50 per cent more sweetening value than the best cane molasses. The best grade cane syrup contains about 30 per cent of water, while honey contains 17 per cent water.

A cup of honey weighs about 12 ounces, of which not quite 1/5 is water.

A cup of sugar weighs about 7 ounces.

Honey then contains a little more sugar than the same measure of cane sugar.

Cup of honey (12 ounces of which about 1/5 is water) contains roughly 9½ ounces sugar.

Cup of honey — about 9½ ounces of sugar.

Cup of sugar—7 ounces sugar.

In substituting honey for sugar in a recipe, the amount of liquid would be reduced one-fifth cup for each cup of honey used. Measuring cups do not show a measure of one-fifth. There are 16 tablespoons to the standard cup. After measuring the liquid, it would be perhaps easier to remove 3 tablespoons and 1 teaspoon of the liquid than to try to figure out how to fill the standard cup four-fifths full.

Sample—Cake recipe calls for 1 cup sugar and ½ cup liquid. To use 1 cup honey, therefore, measure ½ cup liquid and remove 3 tablespoons and 1 teaspoon of the liquid from the original ½ cup.

This is just a general rule. American Honey Institute has found that it is best to use recipes especially worked out for honey and thoroughly tested.

In some cases where certain ingredients like chocolate, dates, raisins, nuts and mixed fruits are used, the honey cake mix will use as much liquid as a regular sugar cake due to absorption qualites of the mixed fruit or chocolate. Certain cakes made with honey when first baked do not seem as sweet as sugar cakes and seem soggier and heavier. These same cakes upon aging become moist, flavorful and improve in texture. Honey has the power to hold moisture and for that reason honey cakes and cookies may be made weeks and even months in advance of time required. In fact, it has been found that cakes made with honey according to tested recipes are the better after aging from one to three weeks, depending upon the amount of honey used.

Take for instance, honey date bars the first day they are made. They will be tough, not sweet enough and hard to chew. Let them age for two weeks in the cookie jar and one will be amazed at the change that has taken place.

To make a honey date bar that can be eaten within a day or two after it is made, add ¼ cup shortening to the recipe.

Oven temperatures are very important in baking honey goods. The carmelization point of honey is low due to its levulose content. Therefore, baking the mixture slowly and evenly and exactly the right amount of time is essential.

A temperature is given and a length of time is given. Try to follow these. If there is no oven regulator, use a slow oven. When the cake has shrunk from the sides a bit, lightly touch the upper crust and when the dent comes back, the cake is done. Honey cakes brown rapidly, this being due to the levulose sugar in honey.

Begin with Simpler Uses

If one is just learning to use honey, start with the simple combinations. The simplest way to use honey is the drizzling method.

Stickiness of Honey Has Its Advantages

Of course, honey is sticy. We wouldn't have it otherwise. The stickiness of honey is an advantage—it helps hold ingredients together. In the case of a rolled sandwich for instance, honey fillings hold the rolls together. You know how difficult it is sometimes to make them hold together.

Honey is a liquid sweet and not a dry substance, for it blends more readily with many combinations. In the case of fruit salad, it is not necessary to stir the fruit to dissolve sugar crystals; just arrange the fruit mixture in a cluster of lettuce and then lightly drizzle over the honey. Since it is a liquid, it penetrates the fruit tissues without stirring and all the fruit is flavored without further agitation.

For ice cream sundaes, honey is ideal —the syrup mixture is ready. Just add the fruit or nuts to the honey and pour over ice cream. Or if a thinner syrup is preferred dilute the honey to the consistency or density you desire.

Granulated Honey Can be Used

Homemakers, who know how to use honey, never worry about honey that granulates. They have pet combinations for granulated honey. Some homemakers put liquid honey into their electrical refrigerators to make it granulate. Then they use it for—

1. Cake Icing, by adding chopped nuts and cocoanut, warming it just enough so it will spread easily. It really is a delightful icing.
2. Hard Sauce, by blending granulated honey with butter. Allow butter to stand in room temperature and to ¾ cup granulated honey, add ½ cup butter and blend thoroughly. This mixture should be prepared as needed and chilled before being served.
3. Candy, by mixing granulated honey with ground dates, prunes, apricots, figs and other dried fruit.

Granulated honey can be used as successfully for making cakes and cookies as well as liquid honey. It is no more difficult to measure.

Measuring Honey

Measure the fat in the measuring cup first, then measure the honey without washing the measuring cup. The honey will come out more easily since the fat has formed a light surface of fat globules around the inner surface of the cup so the honey can be brought out to every last drop. If recipe calls for granulated sugar and honey, say half cup of each, place sugar in cup first and pour the honey on top of the sugar until cup is full. The honey comes out very easily and does not adhere to the cup when sugar is at the bottom.

Always use one of the rubber dish scrapers for taking out fat or honey or batter mixtures from a mixing bowl or measuring cup. These rubber dish scrapers allow one to remove every last drop of honey from the measuring spoon or mixing bowl. There is a honey drizzler type of jar which when filled with warm honey makes it possible to readily dispense honey into the measuring cup or spoon.

Not many additional pieces of equipment are necessary for honey cookery, but it is important that any homemaker have enough of the right kind of cooking equipment but not too much or too little. Plenty of measuring cups, measuring spoons, at least two rubber spatulas or rubber dish scrapers (they can be purchased for 10c) and one or two honey drizzler jars will take care of your requirements.

Importance of Correct Temperature in Honey Cookery

Perhaps the greatest difficulty met with in cooking and baking with honey concerns temperatures. It is the experience of many that more good foods are spoiled through too high a temperature than through too low a temperature. The amateur is quite likely to scorch or bake foods too hard. A scorched spot or surface will affect the flavor of the entire mass and especially of a food containing flour. This is particularly true of honey combinations.

For the apple up-side-down cake, one should always be very careful after the honey (in which the apple rings are placed) starts to bubble to turn the flame just as low as possible and let simmer. Some homemakers make the same apple rings over a high flame only to find in a very short time that the apple rings are too hard and the honey caramelized beyond further use. The liquid from the apple rings can be used over and over again if the rings are cooked correctly.

The same thing applies to honeyed fruit strips, orange or grapefruit. These fruit strips are ruined time after time because they are not allowed to simmer in the honey over the lowest possible flame but instead are boiled briskly.

The guesswork method will not work with honey. Measurements must be exact and temperatures correct.

Know the Honey

The flavor of honey depends upon the flowers from which the bees gathered the nectar. Since there are so many sources of nectar there are, of course, many flavors of honey. The kind of honey one

likes best is usually the honey he had as a child.

Practically all the honey on the market is pure honey. All honey is good honey, but that does not mean all flavors are equally as pleasing to all persons. Insist on tasting honey before making a purchase and then purchase in 5 or 10 pound pails or 60-pound cans—that's the economical and sensible way to buy it. Honey usually crystallizes because of the dextrose sugar which it contains and because of this crystallization, it may be necessary to liquefy honey before using it. This may be easily done by using a double boiler, or the honey container may be set in a pan of water on the stove, but a small block of wood or a metal plate should be placed under the bottom of the container to prevent its coming in contact with the bottom of the heating vessel. Because of the levulose it contains, honey may be easily scorched if overheated.

In general, the lighter colored honeys as clovers, orange, sage, alfalfa and blends of these combinations are milder in flavor and are fine for general use—salads, sauces, fruits, sandwiches and the like. Southern honeys like cotton, sourwood, gallberry, and tupelo are also very good flavored and exceptionally fine for chocolate combinations like brownies, fudge cake, fudge candies, chocolate sour cream cookies. The spicy dark honeys are splendid for gingerbread, fruit cakes, plum puddings, steamed puddings such as suet, Indian, and the like, nut cookies and spiced cider or fruit punches.

Substituting Honey for Other Syrups

Indiscriminate substitution of honey for corresponding amounts of molasses or sugar in recipes does not always give the expected results. The cook should keep in mind the difference in chemical nature between honey and syrup before making up a recipe. Better make a small amount as a test before entirely filling a new recipe.

Less soda is required when substituting honey for ordinary molasses. Experiments in the government nutrition laboratory have shown that ¼ level teaspoonful of soda is generally the amount required with a cupful of honey. In baking with sour milk and soda it is well to add a pinch of baking-powder to every pint of flour. Cakes will be lighter and finer grained if this is done. When baking-powder is substituted for soda use a little more.

A number of experiments in the baking of bread, using varying amounts of honey have been carried on in the Food Research Division of the Bureau of Chemistry and Soils, U. S. Department of Agriculture. They have found that one has to use approximately 5 or 6 per cent of honey before any distinctive flavor of honey is imparted to the bread. Furthermore, they have been able to make a very good loaf of bread with as much as 25 to 30 per cent of honey. Bread made with honey is generally darker in color than that made with a corresponding amount of sugar. The texture of the bread, however, is very good and likewise the volume of the loaf is very satisfactory.

Honey Recipes

All the recipes here given were tested and prepared by Mrs. Malitta F. Jensen of the American Honey Institute.

These recipes are for use in the home. For using honey in baking in large quantities, write to the American Honey Institute at Madison, Wisconsin.

Honey Breads, Muffins, Waffles

Honey Bread—4 cups boiling water (1 quart), 4 tablespoons butter (¼ cup), 4 tablespoons honey (¼ cup), 1 cake yeast, dissolved in ½ cup lukewarm water, 12 cups sifted flour, 5 teaspoons salt. Put honey, salt and butter in large pan, add boiling water. Add dissolved yeast cake to this when lukewarm; then 10 cups flour; stir thoroughly until mixed, using knife or mixing spoon. Add remaining flour, mix, and turn on a floured board, leaving a clean bowl; knead to mix ingredients until mixture is smooth, elastic to touch and bubbles may be seen under the surface. Return to bowl, cover with clean cloth and board or tin cover. Allow to rise overnight in temperature of 65 deg. F. In the morning cut down, toss on lightly floured board, knead to distribute air, shape into loaves, place in greased pan, having pans nearly full. Cover, let rise again to double its bulk and bake in a hot oven. This recipe will make 3 loaves of bread.

Whole Wheat Bread—1 quart whole wheat flour (may be ½ Graham or ⅓ rye), 1 pint water (may be ½ scalded milk, cold), 2 tablespoons honey, ½ compressed yeast cake or the equivalent, 1½ teaspoons salt, 2 tablespoons butter or other fat. Dissolve the yeast thoroughly in water, add honey, mix well, add salt, then flour. Dough should be rather sticky and soft. Cover closely, let dough stand over night in warm place. Next morning turn dough out on board, knead in butter. Make two loaves in narrow pans, cover and keep warm to rise. When double in size bake in 40 to 50 minutes in moderate oven (350 deg. F.)

Honey Nut Bread—2 cups whole wheat flour, 1 cup white flour, ¼ cup brown sugar, 1 cup nut meats, ½ teaspoon soda, 3 teaspoons baking powder (S. A. S.) or 4 teaspoons baking powder (other kinds) 1½ teaspoons salt, ½ cup honey, ¾ cup cold water, ¾ cup milk. Combine dry ingredients. Combine liquid ingredients. Combine dry with liquid and stir until dry ingredients are dampened. Bake 1 hour and 10 minutes at 325 deg. F.

All Bran Fig Honey Bread—1 egg, ¼ cup brown sugar, ½ cup honey, 1 tablespoon melt-

ed shortening, 1 cup Kellogg's All Bran, 1½ cups milk, 2½ cups flour, ¾ teaspoon soda, 2 teaspoons baking powder, 1 teaspoon salt, ½ ½ cup chopped pecans, 1 cup chopped figs. Beat eggs, add sugar, honey and melted shortening. Mix well. All All-Bran. Sift flour with soda, baking powder and salt. Add pecans and figs to flour mixture. Add dry ingredients alternately with milk. Bake in greased loaf tin in a moderate oven (357 degrees F.) for 1 hour and 15 minutes. Makes 1 large loaf.

Honey Date and Nut Bread—¾ cup honey, 1 egg, 1 cup milk, 3 cups flour, 3 teaspoons baking powder, ½ teaspoon salt, ½ cup nut meats (chopped), ½ cup chopped dates. Mix in order given and put into a greased and floured loaf pan. Let stand about one hour. Bake in a slow oven for about 50 minutes to one hour.

Honey Currant Biscuits—½ cup Kellogg's All-Bran, ¾ cup milk, ¼ cup honey, 2 cups flour, 4 teaspoons baking powder, 1 teaspoon salt, ¼ cup shortening, ½ cup currants. Combine All-Bran, milk and honey. Sift together the dry ingredients and cut in the shortening. Add to the first mixture and stir. Turn onto floured board, knead lightly, adding the currants. Shape into biscuits. Place on greased pan and bake in a hot oven (425° F.) about 25 minutes. Yield: 12 biscuits 2½ inches in diameter.

Honey All-Bran Banana Bread—¼ cup butter, ¾ cup honey, 1 egg, ¾ cup Kellogg's All-Bran, 1½ cups flour, 2 teaspoons baking powder, ½ teaspoon salt, ½ teaspoon soda, ½ cup chopped nuts, 1 cup mashed bananas. Cream the butter and beat in the honey and egg. Add the All-Bran. Sift the dry ingredients and mix in the nuts. Add dry ingredients to the creamed mixture alternately with the bananas. Bake in a moderate oven (350° F.) about 1 hour. Yield: 1 loaf (8½x4½).

Honey Pep Muffins—2 tablespoons butter, ¼ cup honey, 1 egg, ½ cup milk, 1 cup flour, 2 teaspoons baking powder, ½ teaspoon salt, 1 cup Kellogg's Pep. Cream the butter and honey. Beat in the egg and milk. Add the sifted dry ingredients and Pep. Fill greased muffin tins two-thirds full and bake in a moderate oven (400° F.) about 25 minutes. Yield: 12 medium sized muffins.

Glazed Biscuits—These biscuits have the appearance of up-side down biscuits, are easy to make, and very delicious. Cut biscuits as usual (baking powder type of biscuit), make indentation in each biscuit, and insert a teaspoon of Quick Marmalade* in each cavity. Brush with butter and bake in the usual manner.

***Quick Marmalade**—Plunge dried apricots in hot water. Drain and run through food grinder (fine knife). To 1 cup of ground apricots (measured after grinding) add 1½ cups honey (liquid or solid). Beat thoroughly so that mixture is entirely blended. Store in sterilized jars at least two weeks. The dried apricots and honey combine to form a spread of marmalade texture. Delicious on toast or hot biscuits.

Honey Cream Waffles—2 cups prepared pancake and waffle flour, 2 eggs, ½ cup milk, 1 cup thick cream, ⅓ cup honey. Add milk to slightly beaten yolks, and add to flour, beating enough to mix thoroughly. Whip cream until thickened, but not stiff enough to hold shape; add honey and fold into first mixture. Cook in a moderately hot waffle iron.

Honey Nut Brown Bread—1½ cups graham flour, 1½ cups white flour, 1 cup raisins, 1 cup walnut meats chopped, 1 teaspoonful soda, 1 egg, 1 cup honey, 1 tablespoonful shortening, 1 teaspoonful salt, 1 cup buttermilk. Sift the two flours. To well beaten egg, add the honey and shortening which have first been slightly warmed and blended. Add the salt, then all the buttermilk except enough in which to dissolve the soda. Stir in the sifted flour, raisins, and chopped nut meats. Then add the dissolved soda. Bake in slow oven for one hour. Enough for two medium sized loaves.

Steamed Brown Bread—Two cups graham flour, sometimes heaped, depending on condition of milk, 1 cup meal, ⅔ cup dark honey or granulated honey, 2 cups sour milk, 1 teaspoonful salt, 2 teaspoonfuls of soda dissolved in one tablespoonful boiling water, stirred into the milk and honey; ½ cup of raisins. Stir thoroughly; fill pound paking powder cans half full; cover tight and steam 3 hours.

Honey Oatmeal Muffins—1 egg, 1¾ cups milk, 3 cups flour, 3 cups oatmeal, 6 teaspoonfuls baking powder, 2 tablespoonfuls shortening, ½ cup honey, ½ cup chopped walnuts, 2 teaspoonfuls salt. Beat egg lightly, melt the shortening and mix with honey. Add this mixture to beaten egg. Mix together the flour, oatmeal, baking powder, salt and nut meats. Alternately add milk and flour to egg and honey mixture until all milk and flour have been added. Bake in well greased muffin tins for thirty minutes in hot oven. (Will make 36 muffins.)

Honey Corn-Flake Muffins—1½ cups corn flakes 1½ cups graham flour, 2 cups white flour, 1 tablespoonful shortening, 2 cups milk, ¼ cup honey, 5 teaspoonfuls baking powder. Mix melted shortening with honey, add to one egg beaten lightly, then add milk. Stir in the dry ingredients which have been thoroughly mixed. Bake in well greased muffin tins for thirty minutes. (Will make 32 muffins.)

Regulation Honey Muffin Batter—1 egg, beaten very lightly, 2 tablespoonfuls shortening, 2 tablespoonfuls honey 1 teaspoonful salt, 2 cups milk, 2 cups white flour, 2 teaspoonfuls baking powder. Mix shortening and honey with beaten egg. Alternately add milk and sifted dry ingredients. Beat until mixture is smooth and creamy. Pour in well greased muffin tins and bake in hot oven for thirty minutes. Serve hot with honey. (24 muffins.)

Honey Baking Powder Biscuits—2 cups flour, 1 cup milk, 4 tablespoonfuls shortening, 2 tablespoonfuls honey, 2 teaspoonfuls baking powder, 1 teaspoonful salt. Sift the dry ingredients together and then cut in the shortening. Mix the honey in milk and then add to biscuits. Work quickly, roll out and cut in rounds about 2 inches in diameter. Serve piping hot with comb honey.

Honey, Date, and Nut Biscuits—Use same dough as for baking powder biscuits. Roll dough into rectangle about ¼-inch thick. Spread with honey, date, and nut mixture given below. Roll up from long side as for jelly roll. Cut in ¾ inch slices, lay with cut side down on greased pan. Bake about 25 minutes in hot oven.

Honey, Date, and Nut Mixtures—½ cup honey, ¼ cup butter, ¼ cup chopped dates and ¼ cup chopped walnuts. Cream honey and butter, then add chopped dates and nuts.

Honey Waffles—2 cups flour, 4 teaspoons baking powder (tartrate) or 2 teaspoons sodium phosphate type, ½ teaspoon salt, ⅛ cup melted fat, 1½ cups milk, ¼ cup warm honey, 3 eggs. Add honey to beaten eggs. Sift dry ingredients and add them and milk alternately to honey and egg mixture. Add melted fat lastly.

Plain Honey Toast—Trim slices of bread (slices should be about ⅜ inch thick.) Toast properly then butter and spread with comb honey.

Honey Cinnamon Toast—Spread slices of fresh toast with butter, brush with honey (about 1 tablespoonful honey for each slice), sprinkle with cinnamon, and oven toast enough to blend cinnamon and honey.

Honey Pecan Toast—Spread slices of fresh toast with butter, then with a paste made of comb honey and salted pecans. (About 2 tablespoons whole salted pecans to 2 tablespoonfuls comb honey.) Press together one slice of plain

buttered toast with 1 slice honey pecan toast. Reheat enough for both sides to absorb honey, and serve piping hot. Extracted honey may be used if preferred.

Honey Cakes

No synthetic or artificial flavoring could duplicate that mellow deliciousness in a honey cake when properly aged. There seems to be a slow chemical blending of some form, which, after a certain period of time, results in a perfect harmonious whole. This aging is necesary in all honey cakes. Experiment yourself and you will find that most honey cakes and cookies improve with every day's keeping.

Basic Honey Cake—½ cup shortening, ¼ teaspoon salt, 2 cups cake flour (sifted before measuring), ½ cup sugar, ⅓ cup milk, 2 teaspoons S. A. S. baking powder or 4 or tartrate baking powder, ½ cup honey, 2 eggs, 2 teaspoons cream. Cream shortening, honey, and sugar. Add beaten eggs and stir until thoroughly blended. Sift dry ingredients together and add alternately with milk to honey mixture. Do not beat after flour has been added—just two or three brisk stirs to be sure it is well blended. Add the cream and pour into 2 layer cake pans, the bottoms of which have been lined with waxed paper. Grease the pans and waxed paper before pouring mixture. Bake in moderate oven (350 deg. F.) 20 minutes.

For Loaf Cake—Bake in well greased pyrex loaf pan about 50 minutes at same temperature as for layer cake.

For Cup or Tea Cakes—Bake in well greased individual pyrex custard cups 25 to 30 minutes in moderate oven (about 350° F.).

Honey Cake Variations

Nut Cake—1 cup chopped hickory nuts may be added to make delicious hickory nut cake.

Mocha Cake—Use ⅓ cup strong coffee in place of milk, and frost with mocha icing.

Honey Pound Cake—¾ cup shortening ¾ cup sugar, ¾ cup honey, 4 eggs (beaten separately), 2 cups pastry flour, ½ teaspoon ginger, ½ teaspoon soda, ½ teaspoon cinnamon. Cream the shortening and sugar. Add honey and well-beaten egg yolks. Sift the flour with the ginger, cinnamon and soda and add to first mixture. Fold in stiffly beaten whites of eggs and flavoring. Beat 5 minutes. Put into a warm tin with high sides and bake for an hour in a moderate oven (350 deg. F.) Yield: 12 servings.

Orange Honey Cocoanut Cake—½ cup shortening, ½ cup sugar, ½ cup orange honey, 5 egg yolks, 1¾ cups all-purpose flour, 3 teaspoonfuls baking powder, ½ teaspoonful salt, ⅝ cup milk, 1 tablespoonful orange rind, 1 tablespoonful orange juice. Cream shortening; add sugar gradually and cream well. Add honey and mix well; add the very well beaten egg yolks. Sift flour once before measuring. Sift flour, baking powder and salt together. Add to creamed mixture alternately with the milk. Add orange rind and juice. Bake in well greased and floured pan for 40 minutes in moderate oven (350° F.). Ice with Honey Cocoanut Meringue.

Honey Sponge Cake—1 cup cake flour, ½ cup sugar, ½ cup strained honey, 5 egg whites, 5 egg yolks, ¼ teaspoonful salt, ½ teaspoonful vanilla, ¾ teaspoonful cream of tartar, 2 tablespoonful boiling water. Sift and measure flour and sugar. Beat egg yolks until thick and lemon colored. Add sugar and beat well; add honey and combine lightly. Add boiling water a tablespoon at a time. Beat ½ minute, add flavoring and flour and lastly fold in the beaten egg whites. Pour into a tube pan and bake for 50 minutes in a very moderate oven (300° F.). When baked, invert on cake cooler and allow to cool before removing from pan.

Honey Citron Nut Cake—½ cup shortening, 4 egg whites, ¾ cup water or milk, 4 teaspoonfuls baking powder, 2¼ cups flour (sifted twice before measuring), ¾ cup honey (mildly flavored), ¾ cup sugar (white), 1 cup sliced citron, 1 cup chopped pecans. Blend shortening, honey and sugar to a cream; add liquid and flour in which baking powder and salt have been sifted. Stir only until mixed and then add nuts and citron, folding in lastly the stiffly beaten egg whites. Pour into layer cake tins or flat oblong pan lined with waxed paper. Bake in moderate oven (350° F.) for 45 minutes to 1 hour, depending on depth of cake. Other fruits or nuts may be used such as preserved watermelon rind, candied orange peel. Ice with Honey Icing.

Spiced Jelly Roll—3 eggs, ⅜ cup sugar, ⅜ cup strained honey, ¼ cup water minus 1 tablespoonful, ½ teaspoon vanilla, 1 cup flour, 1 teaspoon baking powder, ¼ teaspoonful salt, ¼ teaspoonful cloves, 1 teaspoon cinnamon, 2 tablespoonful melted butter. Beat yolks, add sugar, honey water and vanilla. Sift flour, baking powder, salt, and spices, and add to first mixture. Add melted butter and fold in egg whites. Bake in shallow pan lined with well oiled paper in a hot oven (375° F.) for 20 minutes. When baked, invert on a cloth dusted with powdered sugar. Remove paper, trim off edges, spread with spiced roselle or blackberry jam. Roll cloth around cake and allow to "set" for a short time.

Soft Honey Cake—Cream ½ cupful of butter with 1 cupful of honey until well blended. Sift together 2 cupfuls of flour, 1 teaspoonful of soda, ½ teaspoonful of ginger, ½ teaspoonful of cinnamon, and ⅛ teaspoonful of salt. Beat an egg well and add to the honey mixture then part of the sifted dry ingredients. Add ½ cupful of sour milk and the remainder of the dry ingredients. Beat hard and pour into layer cake tins. Bake from 20 to 25 minutes in a moderately hot oven. This cake improves in flavor if kept in a tin box.

Honey Apple Sauce Cake—½ cup lard, 1 cup honey, 1 egg, ½ teaspoon salt, 1 cup apple sauce (thick puree), 1 teaspoon soda, 1 teaspoon cinnamon, ½ teaspoon cloves, 2¼ cups flour. Cream the lard, add the honey and cream until well mixed. Beat egg into creamed mixture. Add the sifted dry ingredients and apple sauce. Pour into greased or lined pan and bake in moderate oven (350° F.) for about one hour.

Variations of Honey Apple Sauce Cake—Honey may be decreased to ½ cup, ½ cup sugar added, and ¼ cup less flour used. Add 1 cup raisins (floured). Add 1 cup raisins (floured) and 1 cup black walnuts (floured) or butter nuts or hazel nuts. Use bacon fat or chicken fat in place of lard.

Honey Spice Cake—1 cup shortening, ⅓ cup sugar, 1½ teaspoonful cinnamon, 3 cups pastry flour, 1 cup sour milk, 1 teaspoonful vanilla flavoring, ½ teaspoonful salt, ¾ cup strained honey, ½ teaspoonful cloves, 4 teaspoonfuls baking powder, ½ cup nut meats (broken), ½ teaspoonful soda, 2 eggs. Cream shortening and add the sugar. Beat in the honey. Beat the yolks of eggs and add. Sift dry ingredients. Add ¼ cup to nuts and add these to the mixture. Add the remaining dry ingredients alternately with sour milk and vanilla. Fold in the beaten whites. Bake in a well greased loaf pan in a moderate oven (350° F.) for 45 minutes.

Honey Gingerbread—1½ cups flour (all cake flour or half cake and half all-purpose flour), ½ teaspoon ginger, ½ teaspoon cinnamon, ⅛ teaspoon cloves, 1 egg, ½ cup fat, ¾ cup honey, ¼ teaspoon salt, ½ teaspoon soda, ½ cup sour milk, ¼ cup brown sugar, 1 teaspoon baking powder. Sift dry ingredients. Cream fat and honey, add brown sugar and egg. Thoroughly blend, then add sour milk and sifted dry ingredients, This will be a thin bat-

ter but do not mind that. Bake in gingerbread pan lined with wax paper which has been well greased for about 25 minutes in moderate oven (375 deg. F.) This is delicious gingerbread and is unusually good served with honey-butter meringue.

Honey Chocolate Cake—¾ cup honey, ½ cup sugar, ½ cup fat, 1 egg, 2 squares bitter chocolate, ¾ cup milk, 2½ cups cake flour, ½ teaspoon salt, ½ teaspoon soda, 2 teaspoons baking powder. Cream sugar, fat and honey thoroughly. Add egg yolk well beaten, then melted chocolate. Add sifted dry ingredients and liquid alternately. Fold in egg white beaten until stiff. Bake in moderate oven (350 degrees F.) for 45 to 50 minutes.

Institute Fruit Cake—1 cup shortening, 3 eggs, ½ cup coffee, ¼ cup citron, 1 cup candied cherries, ¼ cup candied pineapples, ½ pound figs, ½ cup honeyed orange strips* or honey orange marmalade, ¼ cup prunes, ½ pound raisins, ¼ cup dried apricots, ½ pound dates, ½ pound currants, 1½ cups pecans or walnuts, 2 cups honey, 2½ cups flour, ¼ teaspoon each cloves, salt, nutmeg and allspice, ½ teaspoon soda, 1 teaspoon cream of tartar, ¾ teaspoon cinnamon. Run figs, prunes, dates, apricots through food chopper. Add orange strips or orange peel, raisins and currants. Over this pour the honey and let stand from four days to two weeks. Shred pineapple and citron. Sift dry ingredients, reserving ½ cup flour to mix with nuts, cherries and pineapple. After fruit and honey mixture has stood long enough, cream shortening and add to honey fruit mixture. Add the beaten eggs, then sifted dry ingredients, coffee. Then add the floured nuts, pineapple shreds, whole or halved cherries and citron shreds. Bake slowly (225 degrees F.) for three hours in covered baking dishes. (2-lb. size). If the entire mixture is baked in one cake (five pounds) bake from four to five hours, depending on the depth of the cake. Brush top of cake wtih warm honey, wrap in heavy waxed paper, pack away in covered crock for at least a month. Before wrapping in cellophane for gift mailing, or before serving, decorate with cherries, honeyed orange peel, pecans, almonds or brazil nuts and honeyed apples. Yield 5 pounds fruit cake. *Instead of honeyed orange strips or honey orange marmalade, the commercial candied orange peel may be used. Instead of the ½ cup coffee, ½ cup thick cranberry puree may be used. The figs, prunes, dates and apricots that are ground are not cooked but are ground in the dried state.

Cake Icings

Honey, Date and Nut Icing—1 cup dates, ½ cup honey, 2 cups powdered sugar, ½ cup walnuts chopped, pinch of salt, 4 thalespoons whipped cream, 2 tablespoons melted butter. Heat honey over very low flame, add chopped dates and salt. Remove from fire, add melted butter, powdered sugar, whipped cream and chopped walnuts.

Honey Orange Nut Icing—¼ cup honey, 2 tablespoons melted butter, pinch of salt, 2 cups powdered sugar, ¼ cup chopped walnuts, 4 tablespoons whipped cream. Mix honey, butter, whipped cream together, add powdered sugar, walnut meats and salt.

Honey Almond Meringue Icing—⅓ cup honey, 2 egg whites, 1-16 teaspoon salt, ⅓ cup blanched almonds. Heat honey to 240 deg. F., or until it spins an 8-inch thread. Pour slowly into stiffly beaten egg whites and beat with egg beater constantly. Add salt and continue beating until mixture is fluffy and will hold its shape. Spread on warm cake and sprinkle top with almonds, lightly toasted and shaved in thin slices. Place pan of cake on board or in another pan to prevent further browning and return cake to oven to set meringue. Bake meringue 15 minutes. Temperature 325 deg. F., slow moderate oven.

Honey Meringue Icing—Heat 1 cup honey to 238 deg. F., or until it shows a thread when a little is dropped from a spoon. Pour slowly into 2 egg whites stiffly beaten. Continue beating until icing is fluffy and will hold its shape. Icing for 2 layer cake.

White Icing—Beat 2 egg whites until they start to stiffen, then slowly beat in confectioner's sugar to make a stiff icing. Add 1 tablespoon honey for flavor and 1 teaspoon melted butter.

Icings may be made from solid or granulated honey. Add chopped nuts and cocoanut, warming it just enough to spread easily. Mix the solid honey with butter and cocoa for fudge icing. Hard sauce, by blending granulated honey with butter—see directions for making honey butter. Mix with dried fruits and nuts for a chop suey icing or jelly roll filling.

Honey in Canning and Preserving

Honey may be used in place of all or a part of the sugar used in canning, jelly making, preserving, and pickling. The milder flavored honeys are probably most compatible with the less tart fruits for making sauces and jellies. The stronger flavored honeys, particularly those with a spicy flavor, are excellent for pickling purposes and conserves made from tart fruits like gooseberries and rhubarb.

It is somewhat difficult to designate special honeys for special fruits as taste preferences vary. A home maker can best determine her family's preference by experimenting some. All honeys are good but not all flavors of honey are equally as pleasing to all individuals.

An all honey syrup is naturally darker than a sugar syrup. Such a syrup tends to darken the lighter colored fruits as peaches and pears when canned for sauce. However, the original fruit flavor is intensified. If one prefers a lesser degree of the original flavor of the fruit, it is better to replace only from one-fourth to one-half of the sugar ordinarily used with the honey.

In using honey, two precautions should be observed:

1. Since honey has a tendency to foam considerably when heated, there is some danger of the product "cooking over" at the beginning of the cooking period if a large enough preserving kettle is not used or the syrup carefully watched.

2. Since honey is part water, it is necessary to cook the product in which it is used slightly longer in order to obtain the desired consistency.

Honey in Sauces—For the syrup—Bring water to boiling point. Add the honey and stir. Again let come to a good rolling boil. Remove all scum. Canning by Cold Pack Method—Pour the boiling syrup over the fruit which has been packed in sterilized jars. Process according to standard schedule, as given in Farmers' Bulletin 1471, U. S. Department of Agriculture. Canning by hot pack method. Add fruit to boiling syrup (directions given above.) Allow to come to a good rolling boil. Fill sterilized jars.

Process accordnig to standard schedule, already referred to. At the Institute Testing Kitchen the following proportions for the various fruit sauces were preferred: †Syrup.

Fruit	All honey.	Honey and sugar.
Cherries (tart)	2 cups honey	1 cup honey
Plums (tart)	3¾ cups water	1 cup sugar
Apples (tart)		4 cups water
Strawberries		
Pineapple	1 cup honey	½ cup honey
Raspberries	2 cups water	½ cup sugar
Peaches		2¼ cups water
Sweet Black Cherries		

†Be sure to remove all scum from the syrup before pouring over fruit in jars or adding the fruit if the hot pack method is used.

Jams and Jellies

Crabapple, apple, plum, quince, and currant jellies can be successfully made by using ¾ cup honey to 1 cup of juice or half honey and half sugar may be used.

All Honey—Boil the juice 10 minutes. Add honey and cook to 220° F. Remove scum. Pour in hot sterilized glasses. Cover with paraffin.

Honey and Sugar—Boil the juice 10 minutes. Add sugar and bring to boiling point. Add honey and cook to 220° F. Remove scum. Pour in hot glasses and cover with paraffin.

Honey Jelly—2½ cups honey, ½ cup water, ½ bottle liquid fruit pectin. Mix honey and water in preserving kettle. Bring to full boil as quickly as possible. Add liquid pectin, stirring constantly. Bring to full rolling boil. Remove from fire at once and skim. Quickly pour into hot glasses. Cover with paraffin.

Strawberry Jelly—1½ quarts fully ripe berries, 4 cups honey, 3 cups juice, ⅛ bottle liquid pectin. Crush the ripe berries. Squeeze out juice. Drip through cotton flannel for sparkling product. Measure 4 cups honey and 3 cups juice into preserving kettle. Stir, bring to boil. Add the pectin, stirring constantly. Bring again to full rolling boil and allow to boil for 20 seconds. Remove from fire, let stand one minute, skim. Pour quickly into hot glasses. Cover at once with paraffin.

Cherry Jelly—2 quarts of juice, 1 quart of honey. Crush cherries, Cook slowly without water till tender. Drip through cotton flannel. Measure 1 quart of honey to 2 quarts of juice. Boil until it double drops from the spoon. Remove scum, pour into hot glasses. Cover with paraffin.

Peach Jam—3 pounds peaches, 2 cups honey, ¾ teaspoon allspice, 1½ teaspoons whole cloves, 3 teaspoons broken stick cinnamon, 3 tablespoons lemon juice, ¾ cup peach juice. Put spices in cheesecloth sack. Cook slowly all ingredients until of desired consistency. Remove bag of spices. Place in sterilized jars and paraffin.

Preserves

Sunshine Preserves—Allow 1 pound of honey for every pound of fresh fruit. Mix and spread on platters. Place platters in box slightly higher at back than front. Cover with glass. Place in sunshine on a bench. When preserves are thick, put in sterilized jars and seal.

Apple Butter—2 quarts cooking apples, ½ teaspoon ground cinnamon, pinch allspice, 1 pint honey (1½ lbs. or 2 cups), 1 tablespoon lemon juice, 1 pint vinegar. Cook slowly several hours. Stir frequently to prevent sticking and scorching. When thick, can in sterilized jars. Paraffin and seal.

Ginger Pears—Wash, pare, core and cut into very thin slices hard underripe pears. Allow 4 lbs. honey to 4 lbs. pear slices. Add ½ cup water. 1 ounce ginger root cut into small pieces, 2 lemons using the rind (cut in very thin strips). Simmer all ingredients very slowly. When thick as marmalade, seal in hot sterilized jars.

Pineapple Watermelon Preserves—1 lb. honey, ¾ cup water, 1 teaspoon salt, juice of 1 lemon, rind of ½ lemon, ½ teaspoon ginger, 1 lb. watermelon rind cut into small cubes. Simmer gently for 3 hours. Add 1 cup crushed pineapple. Cook 1 hour longer. Seal in sterilized jars.

Bar-le-duc Currants — The bar-le-duc of France is world famous. It commands a high price which is justified both by its reputation and quality. The seeds are removed from the currants by a method which mutilates the fruit very slightly and the fruit preserved in honey. A good way to remove the seeds is to cut a small slit in side of each currant and by means of a needle remove the seeds. Weigh the currants. Allow an equal weight of honey. Bring the honey to boiling point. Add the currants and boil two or three minutes until skins are tender. Care should be taken not to let mixture boil so violently as to destroy the shape of the fruit.

Orange Marmalade—3 medium size oranges, 2 cups honey (2 cups honey makes a heavy sweet marmalade—1¾ cups honey not quite so sweet), 1 cup water, 6 tablespoons lemon juice, ¼ cup liquid fruit pectin. Run oranges through food chopper (fine knife). Measure and you should have from 1¾ to scant 2 cups ground orange (skin, pulp, and all). Add water, simmer 15 minutes after it has come to good boil. Add honey, bring to a boil, then simmer 30 minutes. Add lemon juice. Add liquid pectin. Bring to full rolling boil and allow to boil 30 seconds. Remove from fire, skim by turns for about 5 minutes. This slight cooling should prevent floating fruit. Pour quickly in sterilized glasses. Paraffin at once.

Pickles

Apple, Peach† and Pear† Pickles—3 cups honey, 3 cups vinegar, 2 cups water, 1 teaspoon salt. Bring these ingredients to a boil. Add fruit and cook till tender. Pack in sterilized jars and seal. For apples tie the spices* in cheesecloth sack and boil in pickling syrup. For pears and peaches stick the whole cloves† in the fruit and allow stick cinnamon to cook in the pickling syrup. *Spices consist of cloves and cinnamon. †Two to three whole cloves to each pear or peach, depending upon size of the fruit.

Chutney Sauce—2 onions, 1 green pepper, ½ cup hot red pepper, 3 green tomatoes, 3 tart apples, 1 cup raisins, 3 cups crushed pineapple, ½ cup vinegar, ½ teaspoon ginger, 2 tablespoons salt, 2 tablespoons mustard powder, pinch of red pepper, 1 cup honey, juice of 1 lemon. Run through food chopper the first six ingredients. Add the other ingredients and simmer slowly for 2½ hours. Pack in jars and seal.

Cucumber Pickles—2 quarts cucumbers, ¼ teaspoon ginger, 4 cups vinegar, ¼ teaspoon cinnamon, ⅛ teaspoon allspice, 2 cups honey, 1 teaspoon celery seed. Mix spices, vinegar and honey. Let come to a boil. Pour over cucumbers and seal.

Cauliflower Pickles—Remove outside leaves and stalks, then wash cauliflower thoroughly. Break in to small flowerets. Cook in boiling salted water for 12 minutes. Rinse in cold water. Pack pieces in hot sterilized jars. Fill the jars with honey spiced vinegar prepared as follows: 1 quart vinegar, ½ cup honey, 1 stick cinnamon, 1 teaspoon celery seed, 2 small onions sliced, 1 teaspoon whole cloves, 1 teaspoon allspice. Boil this mixture 15 to 20 minutes. Strain and it is ready for pouring over cauliflower. Seal while hot.

Miscellaneous

Honey Vinegar No. 1—2 lbs. of honey, 1 gallon of water. Dilute honey with part of the water and then heat to 200° F. Scald the barrel or crock in which vinegar is to be made. Pour in diluted honey and add the remaining water.* Add a fruit juice to start fermentation. Cover with a closely woven cloth to keep out dirt and prevent entrance of undesirable yeasts or bacteria. From 6 to 12 months are required for proper ripening. *Use the purest water

available to avoid contamination. If rain water is used, boil.

Honey Vinegar No. 2—1 quart of honey, 8 quarts warm water. Mix together. Allow mixture to stand in a warm place until fermentation ceases. Seal in clean jars. (From Ball Blue Book fo Canning and Preserving Recipes by

Honey Cookies

Honey All-Bran Spice Cookies—¼ cup shortening, ¾ cup honey, 1 egg (well beaten), 1 cup Kellogg's All-Bran, 1⅓ cups flour, ½ teaspoon salt, ⅛ teaspoon cloves, 1 teaspoon cinnamon, 1 teaspoon baking powder, ¼ teaspoon soda, 1 cup chopped raisins. Cream shortening and honey. Add egg, All-Bran, sifted dry ingredients and raisins. Drop by teaspoonfuls on greased baking sheet 2½ inches apart. Bake in moderate oven (400° F.) about 30 minutes. Storage improves the flavor of these cookies. Yield: 2½ dozen cookies 3 inches in diameter.

Honey Meringue Squares—1¾ cups cake flour, 1 teaspoon baking powder, sift together, ½ cup butter, ½ cup honey, ½ cup sugar, 2 egg yolks, ½ cup finely chopped nuts. Meringue—2 egg whites*, ¼ cup sugar, ¼ cup honey. Directions: Sift flour, measure and re-sift with baking powder Thoroughly blend honey, sugar, butter, and egg yolks. Stir vigorously. Fold in dry ingredients and nuts. Spread smoothly over the surface of well greased shallow pan about 7½ x 15 x 2. Cover dough with meringue which is made by beating the egg whites until stiff and adding the honey and sugar gradually until the mass is smooth and holds its shape. If an electrical beater is used, whip all together. Bake at 325 to 350 degrees F. 40 to 50 minutes depending on depth of dough. Cut while warm with sharp knife dipped in hot water *For deeper meringue use 3 egg whites with ⅓ cup honey and ⅓ cup sugar. Makes finished product very rich.

Honey Nut Brownies—2 eggs, ½ cup honey, 2 ounces chocolate, ¼ cup butter, ½ cup sugar, ½ cup flour (sifted with ¼ teaspoon baking powder), 1 cup chopped nut meats. Melt butter and chocolate together. Add honey, then flour and chopped nuts. Bake 45 minutes in a slow oven. For immediate use, it is better to use half sugar and half honey. To pack away in jar, use all honey instead of part sugar, and do not serve the cookies until they have aged at least two weeks.

Honey Oatmeal Cookies—1 cupful honey, ⅔ cupful fat, ½ teaspoon salt, 2 eggs beaten, 2 cupfuls rolled oats, 2 cupfuls of flour, ½ teaspoon soda, 2 teaspoons baking powder, 1 teaspoon cinamon, 1 cupful chopped raisins. Cream the fat and honey together, then add the eggs. Mix and sift the flour, soda, baking powder, cinnamon, and salt, and add to the wet mixture together with oatmeal. Dust the raisins with some of the flour and add them to the dough, mixing well. Drop by teaspoonfuls on a greased pan. Bake in a moderate oven 10 to 12 minutes.

Honey Sour Cream Cookies—4 egg yolks, 1 teaspoon soda, ¼ cup sour cream, 4⅓ cups flour, pinch of salt, 1½ cups brown sugar, 1 cup Kellogg's All Bran, 1 cup shortening, 1 cup honey, 1 cup nut meats (chopped). Cream shortening, sugar, honey and yolks. Add sour cream. Then sifted dry ingredients. Add All Bran and chopped nuts. In case all flour is preferred use 5¼ cups flour and omit All Bran. Drop by spoonfuls on greased cookie sheet and bake at 350 degrees F. for 12 to 15 minutes. After taking from oven, let pan sit for 1 minute, then remove cookies at once; otherwise they will stick.

Honey Date Bars—Three eggs well beaten; mix with one cup honey. One teaspoon baking powder sifted into one cup flour (half white flour and half All-Bran or all whole wheat flour may be used): then add pinch of salt, one pound chopped dates, one cup whole nuts. Bake in moderate oven about forty-five minutes in long, flat tin (mixture spread one-fourth to one-half-inch thick) Pack slabs wrapped in waxed paper in covered jar or cake box and keep at least two weeks before serving. This Date Bar has kept in splendid condition six months. Before serving cut in strips; roll in powdered sugar, or top with Honey Meringue. If you do not wish to age these date bars two weeks before using, add ¼ cup shortening to the mixture, blending it with the honey. They are soft enough then for immediate eating; but even with this addition of fat are better when allowed to stand 2 or 3 days first.

A Tasty Date Bar Service—Place two date strips on a plate; top with two tablespoons of ice cream and over this drizzle a little honey; dress top with spoon of honey-sweetened whipped cream and a cherry. Delicious with a topping of Honey Butter Meringue.

Baked Honey Fudge—½ cup butter, 1 cup nut meats, ½ cup honey, ⅓ cup cocoa, ½ cup sugar, ¼ teaspoon salt, 2 eggs, ½ cup cake flour. Cream honey, sugar, fat and eggs thoroughly. Then add sifted dry ingredients and broken nut meats. Bake in paper baking cups inside muffin tins at 325 degrees about 30 minutes. Make honey cookies in advance, they are the better when aged.

Honey Refrigerator Cookies (Basic Recipes)—½ cup honey, ½ cup brown sugar, 1 egg, ½ cup shortening, 2½ cups flour, ½ cup nut meats, 1 teaspoon baking powder, ¼ teaspoon soda, ½ teaspoon salt. Cream honey, sugar, shortening, egg. Add dry ingredients, then nuts, shape in loaf and wrap in waxed paper or place in refrigerator cookie mold. Chill one or two days to allow sufficient ripening of dough. Slice off and bake in hot oven (400 degrees) F. 10 to 12 minutes.

VARIATIONS

Peanut Butter Refrigerator Cookies—Use basic recipe, reduce shortening to ¼ cup, add ½ cup peanut butter, blend peanut butter with fat and proceed as above.

Chocolate Refrigerator Cookies—Add 4 to 6 tablespoons cocoa to basic recipe (depends on degree of chocolate flavor preferred.) Proceed as above.

Fruit Filled Refrigerator Cookies—Use basic dough and allow to ripen as indicated under basic recipe. Run ½ cup dates, ½ cup figs, ¼ cup raisins, ¼ cup cherries and ¼ cup nuts through food chopper. Add enough honey to make it stick together (¼ to ⅓ cup). Shape this in loaf slightly smaller in diameter than loaf of dough. Wrap in heavy waxed paper and place in refrigerator. Fruit roll will become very stiff. Slice off thin slice of dough, place on this a thin slice of fruit roll, top with another slice of thin dough. Bake 15 minutes in hot oven (400 degrees F.). Any combination of dried fruits may be mixed with honey as a filling.

German Honey Cookies

Really good German honey cakes, Honig Kuchen as they are called, are made by getting the honey doughs ready early in the fall. The foreign bakers state that aging the dough improves the cookies and that the acidity of the doughs adds excellence to their other good qualities, makes them mellow and richer, thus producing a better eating cake. For quick, short-time mixtures shortening is added and that type can be made up after standing over night. Oven temperatures are very important in baking honey goods. This question as well as an easy way to measure honey are discussed in the leaflet, "Using Honey," published by American Honey Institute, which it would be well to read before proceeding with the following formulas:

Simple Honey Cake or Braunschweiger—½ cupful honey, 2 cupfuls brown sugar, ⅓ cupful fat, 4¼ cupfuls flour, 1 teaspoon cinnamon, ¼ teaspoonful each of cloves and mace, 1 teaspoon of soda, 1 egg, 1 tablespoon lemon juice, 1 tablespoon grated lemon rind, 1 tablespoon cream. Mix the sugar with the honey and heat over a gentle flame until well melted, but do not boil. Add the fat, lemon juice and rind,

and cool. Then combine with cream to which the beaten egg is added and stir into the flour sifted with spices and soda. Let stand at least a week; then roll one-eighth of an inch thick, adding more flour if necessary. Cut into assorted shapes and bake in a moderate oven 350 degrees F., for about 15 minutes.

Lebkuchen—1 pound extracted (liquid) honey (1⅓ cups), ½ teaspoon soda, 2 cupfuls light brown sugar, ¼ cupful water, 2 eggs, 8 cupfuls flour (about), 1 teaspoon cinnamon, ¼ pound citron and candied orange rind (shredded), ½ pound blanched and shredded almonds, ¼ teaspoon cloves, ¼ teaspoon nutmeg. Boil sugar, water and honey for five minutes, then cool and mix in the flour sifted with the spices and soda. Add the eggs, the almonds and the peel, work into a loaf and leave two or three days to ripen. Work again lightly, adding a little more flour if necessary. Roll out one-quarter of an inch thick and cut in oblong pieces 1 by 3 inches. Bake on a greased pan in a moderate oven—350 deg. F.—for fifteen mniutes. When cool, cover with transparent icing made by mixing 1 cupful of confectioner's sugar to a paste with five teaspoonfuls of boiling water and 1 teaspoonful of honey.

Pfeffernusse (Peppernuts) — 1 teaspoon ground cloves, 1 teaspoon nutmeg, ⅛ teaspoon cinnamon, ½ teaspoon soda, 5½ cupfuls flour, 4 eggs, ½ cupful honey, 1½ cupfuls brown sugar, ½ teaspoon salt. Stir the brown sugar slowly into the slightly beaten eggs, add honey, then add the flour, soda and spices sifted and mixed together. Let stand several nights or a week to ripen. Roll a half inch thick and cut with a small round cutter (about ½ inch in diameter) and let stand overnight on an oiled baking sheet. In the morning bake in a moderate oven—350 deg. F. for fifteen minutes. When cool frost with white icing. If desired, chopped almonds or citron may be added to these cakes. These are very hard when first made and at least three weeks must be allowed for softening and ripening.

Honey Krisp Cookies—⅓ cup shortening, ½ cup honey, 2 eggs (well beaten), ½ cup sour cream, 1¾ cups flour, 1 teaspoon baking powder, ¼ teaspoon salt, ½ teaspoon soda, ½ cup nutmeats (black walnuts are delicious), ½ cup chopped dates, 1 cup Kellogg's Rice Krispies, nutmeg or vanilla flavoring. Cream shortening and honey. Add eggs and sour cream. Sift the flour with baking powder, salt, soda and add to first mixture. Stir in nut meats, dates, Rice Krispies and flavoring. Drop from a dessert spoon on greased baking sheet and bake in moderate oven (375° F.). Yield: 2 dozen cookies.

Honey Spice Cookies—⅓ cup butter, 3 tablespoons sugar, ½ cup honey, 1 egg, ¾ cup all-purpose flour, ½ teaspoon baking powder, ⅛ teaspoon cinnamon, ⅛ teaspoon nutmeg. Cream butter and sugar thoroughly. Add honey and well-beaten egg and cream again. Sift flour, measure and sift again three times with baking powder and spices. Add to creamed mixture. Drop by teaspoonfuls 3 inches apart on buttered baking sheet and bake 10 minutes in a moderately hot oven, 375 degrees. 3 dozen small wafers. Note—This is a thin dough and will spread.

Entrees and Cocktails

Honey fruit cocktails are bound to coax the most lagging appetite. In the case of sugar, there is a tendency to take away the desire for other foods, increasing only the appetite for more sweets. This is not true of honey; it creates a tempting appeal for more wholesome combinations.

Fruit cocktails are the more tempting when made with honey. They increase the appetite for the wholesome combinations that follow in a well planned menu.

Honey Tomato Juice Cocktail — 2 cups tomato juice, 4 tablespoons lemon juice, 2 teaspoons honey, ¼ teaspoon salt. Mix ingredients thoroughly. Chill and serve. Yield: 4 servings.

Vitality Cocktail—Juice of 2 oranges, juice of ½ lemon, yolk of 1 egg, and 2 tablespoons warm honey. Beat the ingredients together and serve.

Luncheon and Dinner Dishes

Sweet Potato Boats with Pecans—Cook unpeeled sweet potatoes until tender. When cool, pare, cut in half lengthwise, scoop out rounds in center about an inch in diameter and half an inch in depth. Arrange these sweet potato boats in baking dish and spread each one lightly with a mixture of honey and fat or honey and butter—equal portions of the honey and fat. Fill cavities with chopped pecans. Brown in oven for about 15 minutes.

Spinach Ring—Drain well 2 cups cooked spinach (either canned or the cooked fresh type). Add 3 tablespoons melted butter and ½ cup medium thick cream sauce to which 1 teaspoon of honey has been added. Season with salt, pepper, and a bit of nutmeg if that flavor is desired. Fill a ring mold (small size) and heat well in a moderate oven. Turn out the spinach ring on a hot platter, fill the center with creamed chicken or scalloped tuna fish. Garnish with pimento. Creamed eggs, creamed mushrooms, or fricassee of crabmeat, also make very desirable fillings for center.

Festive Ham—A ham weighing 9 to 10 pounds, 2 cups honey, 1 quart pickle juice (pineapple juice or gingerale may be used). Give ham its preliminary cooking the day before. Ham is brought to boil, simmered, allowing 20 minutes to the pound. Use the pickle juice in water in which ham is boiled. Remove ham from liquid, skin, pour over 2 cups honey, let stand over night. The next day add enough liquid which has been reserved from the boiling liquid, for basting purpose. Rub the skinned surface with bread crumbs, baste frequently with honey liquid to which 1 cup chopped Maraschino Cherries has been added. Bake the ham, uncovered, in moderate oven (350 to 375 degrees F.) for 1 hour, or until nicely browned on top. Top of ham may be marked off into squares and a cherry placed in center of each square. Garnish with parsley.

Pies, Puddings, Tortes, Custards

Honey Cheese Torte—½ cup cottage cheese, ¼ to ⅓ cup honey, pinch of salt, 2 eggs. Beat eggs and add to cottage cheese and honey which have previously been mixed. Mix well and pour into pie pan lined with graham cracker crust. Sprinkle over the following topping: 1 tablespoon butter, ½ cup graham cracker crumbs, 3 tablespoons honey. (Blend butter and honey, stir in graham cracker crumbs). Graham cracker crust is made by crumbling the crackers fine (12 large or 26 small) and mixing them with ⅓ cup softened butter and 1 tablespoon of honey. Press mixture in an even layer firmly against sides and bottom of a buttered pie plate. Use ordinary pie crust if desired. This recipe makes 1 torte 18 inches in diameter, 1¼ inches deep.

Honey Raisin Crumb Pie—1 egg yolk, ¾ cup honey, ¼ cup hot water, ¾ cup bread crumbs, ¼ cup flour, 1 teaspoon cinnamon, ⅛ teaspoon ginger, ¼ teaspoon nutmeg, 2 tablespoons butter, ½ cup raisins. Blend hot water with honey and add egg yolk. Mix flour, crumbs and spices. Rub in butter. Place a layer of raisins on unbaked pie shell, cover raisins with layer of nut meats, and pour over honey-water-egg mixture. Top with layer of crumb mixture. Bake at 450 degrees F. until crust browns at edges, reduce to 325 degrees F. for 20 minutes or until firm.

Sour Cream Pie—3 eggs, ½ cup honey or ⅓ cupful.* 2 tablespoons flour, 1 teaspoon cinnamon, 1 cupful sour cream, 3 tablespoons honey. Separate the eggs and beat the yolks; add the honey which has been blended with the

flour and cinnamon. Add the sour cream, 1 cupful of chopped raisins or dates may be used. Cook until thick. Pour in a baked shell. Beat the egg white to a stiff froth and add 3 tablespoons of honey. Spread on top of the pie and brown lightly in a very slow oven. *When ½ cupful honey is used the honey flavor is very predominant and the pie is very rich. One-third cupful of honey will probably be more satisfactory for the average taste.

Honey Apple Pie—Make pie as usual, but do not use any sugar with the apples—just the butter and cinnamon, and do not use a top crust. After it is baked, drizzle three-fourths cup of honey over the apple filling and let pie stand until apples become soft and absorb all the honey. Then serve.

Honey Pecan Pie—¾ cup honey to 1 cup (depending on richness and sweetness desired), 3 eggs, 1 cupful broken pecans, ¼ teaspoon salt. Beat eggs slightly. Add honey, pecans and salt. Mix well, put in partly baked pie shell and bake in a moderate oven (325 degrees F.) forty minutes.

Honey Cream Pie—1¼ cups milk, ¼ cup flour, ½ teaspoon salt, 2 tablespoons butter, ½ cup honey, 2 egg yolks, beaten. Add milk slowly to flour, beating until smooth. Add rest of milk, salt and honey. Cook in double boiler, stirring frequently, until thick. Cool slightly and beat in egg yolks thoroughly. Return to low fire, cook 5 minutes, add butter and pour into baked pastry shell. Cover with meringue made from 2 egg whites beaten stiff with 2 teaspoons honey and ½ teaspoon baking powder.

Honey Pumpkin Pie—1 tablespoon gelatin, ¼ cup cold water, 1½ cups cooked pumpkin, 1¼ cups milk, ¼ cup honey, 2 tablespoons butter, 1 teaspoon cinnamon, 1 teaspoon ginger, ¾ teaspoon salt. Add gelatin to the cold water and allow to soak. Combine other ingredients and heat together in double boiler. Add softened gelatin. When cool, pour into Corn Flake shell. Serve with honey-sweetened whipped cream. Yield: 1 9-inch pie.

Honey Corn Flake Shell—1¼ cups fine Kellogg's Corn Flake crumbs, ¼ cup butter, melted, 1 tablespoon honey. Melt butter in pie pan. Add honey and Corn Flake crumbs and mix thoroughly. Mold to form shell. Yield: 1 9-inch shell.

Honey Whipped Cream—½ pint whipping cream, 3 tablespoons honey. Whip cream until stiff. Beat in honey.

Honey Apricot Tartlets—Roll out pastry dough as for pie shell. Cut in two-inch squares. Place a teaspon of Quick Marmalade* on half of each square. Fold over other half and crease down with fork. Bake at 400° F. until a delicate brown. *Directions for making Quick Marmalade are given on page 428.

Mary Barber's Honey All Bran Pudding—¼ cup butter, ½ cup milk, ½ teaspoon salt, 1 egg (well beaten), ⅝ cup honey, 1 cup flour, 1 cup seedless raisins, ½ teaspoon soda, ⅛ cup Kellogg's All Bran. Cream butter and honey together. Add egg, milk, and All Bran. Sift dry ingredients and mix with the raisins. Add to first mixture. Combine thoroughly and put into greased mold; cover tightly and steam for two hours. Serve with hard sauce. Yield: 6 large servings.

King M'das Dessert—Square of sponge cake, warm honey, scoop of ice cream, banana slices. On square of sponge cake, place round of ice cream. Drizzle warm honey over this (about 2 tablespoons to a serving) and cover with slices of banana.

Betty Crocker's Baked Honey Custard—2 eggs, ¼ cup strained honey, 2 cups milk, ⅛ teaspoon salt. Beat the eggs slightly. Add milk, honey, and salt. Strain into individual molds and set in pan of water and bake 30 minutes in a moderate oven (350° F.). Yield: 6 servings.

Mary Ellis Ames' Peach Honey Cobbler—Recipe serves 6. Temperature 425° F. Time: 15 to 20 minutes. 6 peaches, ⅛ teaspoon cinnamon, ¼ cup honey, 2 teaspoon butter. **Crust top**—1 cup Pillsbury's Best Flour, ¼ teaspoon salt, 1½ teaspoons baking powder, 2 teaspoons sugar, 2 tablespoons shortening, ⅜ cup milk. Pare and slice peaches (or use canned fruit); place in bottom of individual cups or baking dishes. Add the honey, sprinkle with cinnamon, and dot with butter, using the quantites given. Sift flour, salt, baking powder, and sugar together. Rub or cut in the shortening. Add milk to make a biscuit dough soft enough to drop easily from a spoon. Divide the dough evenly between the 6 cups, dropping it lightly on the prepared fruit. Bake in a moderately hot oven until fruit is tender and crust browned. Serve warm with cream or Honey Butter hard sauce.

Salads and Salad Dressings

A delightful and easy way to use honey is in salads and salad dressings. Honey brings to these wholesome combinations its own inimitable flavor—the fragrance of blossoming orchards and flowering prairies. Salads are an important addition to any meal. When dressed with honey they please the eye and that is necessary for real enjoyment of food.

When you dress salads the honey way, you are using a natural sweet—nectar stored in perfect packages by the unexcelled workers in the bee kingdom. Honey stands high in the list of energy foods from the nutritional standpoint and it is sweetness plus flavor.

One of the best ways to dress fruit salads is with a drizzling of honey. Watch the honey penetrate the fruit tissues after the pieces have been honey drizzled—it's a part of the whole in a minute. There's complete blending— the sugars in fruit and honey are natural sugars.

Directions for Drizzling Honey

The honey for drizzling should be warm. A pitcher with a sharp snout or the regular honey drizzler jar is the best type of container from which to drizzle honey. Warm honey will drizzle whereas cold honey comes down in one heavy pour stream making any dish too sweet. Place the honey jar in warm—not hot—water for about ten minutes before using. The honey is just the right consistency then to drizzle tiny threads about the salad. You can direct the thin flow of warm honey as desired. It is well to let the members of your family find the honey service pitcher or jar warm and free of stickiness so the honey flows readily.

Sweet Salad Dressing—2 eggs, 4 tablespoons lemon juice, ½ cup liquid honey. Cook until thick and smooth. When ready to mix, add ½ cupful whipped cream. This dressing is quite sweet and is best used with tart fruits.

Fruit Salad Dressing—1 tablespoon butter, 2 tablespoons liquid honey, 2 tablespoons vinegar, 2 eggs, ½ pint whipped cream to be added after other ingredients are cooked. Beat eggs in double boiler. Add all ingredients and cook

until thick, then let cool and add whipped cream.

Honey Dressing for Fig and Date Salads—Mix 3 tablespoons liquid honey with 1 of lemon juice.

Popular Fruit Salad Dressing—2 eggs, 3 taspoons honey, 2 tablespoons lemon juice, pinch of paprika, ¼ teaspoon salt, 1½ cups whipped cream. Beat whites and yolks separately and whip in honey, lemon juice, salt and paprika. Place in double boiler on stove and whip until sauce thickens. Remove from fire, cool and then fold in whipped cream. Keep in refrigerator until ready to use.

Delicious Fruit Salad Dressing—Beat 1 package of cream cheese, 2 tablespoons liquid honey, 1½ tablespoons lemon juice, the grated zest of lemon rind, ¾ teaspoons salt and ½ teaspoon paprika. Have ready ¾ cup cold salad oil. Add 1 tablespoon oil at a time and beat constantly until 4 tablespoons have been used. Add remaining oil, 2 tablespoons at a time and continue beating vigorously. The grated zest of lemon rind is optional.

Boiled Honey Dressing—1 egg, 4 tablespoons melted butter, ½ cupful vinegar, 1 tablespoon flour, 1 teaspon salt, 1 tablespoon cornstarch, ½ teaspoon mustard, 2 tablespoons honey, 1 cupful milk, dash cayenne pepper. Stir butter and flour together; add milk and let cook in top double boiler until thick. Add salt, pepper, honey, mustard and vinegar to beaten egg and stir into the thickened mixture. Cook until thick. Stir constantly. This may be diluted with whipped cream and honey or Honey Meringue for fruit salads.

Dressing made with Honey Meringue—Many delightful yet quickly made dressings can be prepared through the use of Honey Meringue. Because this mixture keeps so well, it is desirable to keep it on hand always. It should be kept in the refrigerator. The mixture should be placed in a flat bowl to no greater depth than 1 to 1½ inches and should always be uncovered. Two methods for its making follow: Electric Beater: Use ⅛ to ⅛ cup honey to one egg white. Put in bowl of mixer and turn on Speed 2. Allow mixture to whip until it peaks. Hand Beater: Put ¼ cup honey in bowl with one egg white and beat with double rotary beater until stiff. Requires good vigorous and steady beating.

Simple Fruit Salad Dressing—Add 1 teaspoon prepared mustard and 1 tablespoon lemon juice to 1 cup honey meringue.

Waldorf Salad Dressing—Add ½ cup Honey Meringue to ½ cup mayonnaise.

Lettuce and Pineapple Salad—Blend 2 ounces cream cheese wtih 1 tablespoon catsup and 4 tablespoons French Dressing. Add to 1 cup Honey Meringue. For Pear Salad—Add 1 teaspoon prepared mustard to 1 cup honey meringue.

Mixed Fruit Salad—Cut orange, pear, pineapple, banana and any other fruit you have for fruit salad. Heap in clusters on nest of tuce. Drizzle warm honey about the fruit.

Apricot Salad—Lay three or four apricot halves (canned) on bed of lettuce, cavity side up. Fill these cavities with warm honey (less than a teaspoon per cavity). Place a rosebud of whipped cream or cream cheese in the center of the filled hollows and a tiny piece of machino cherry on the cream rose bud.

Apple Cheese and Nut Salad—2 cups apples diced, 1 cup cottage cheese, ½ cup chopped walnuts, 3 tablespoons honey, ¼ cup mayonnaise. Mix apples and cheese together. Add walnuts, honey and mayonnaise. Heap on beds of lettuce (about two tablespoons to a serving.) Garnish with julienned green pepper pieces.

Honey Fruit Special—Cut a good sized orange with skin intact in half. Hollow out enough of the center to hold two tablespoons of fruit mixture. Then with sharp knife trim off outer skin. Fill cavity with the following mixture: Dice two slices of canned pineapple, one ripe banana, 2 tablespoons Malaga grapes, and ¼ cup celery. Mix with 2 tablespoons of mayonnaise, 2 of whipped cream, 1 tablespoon of honey, 1 tablespoon orange juice. Add pinch of salt and cover the fruit filled cavity of the orange with this mixture. Garnish with fresh strawberry.

Full-flavored Sundaes

Honey alone, slightly warmed and poured over either vanilla or chocolate ice cream, makes a delicious sundae. When combined with fruits and nuts, honey provides unusually delightful sundaes, and the following will provide an attractive variety for ice-cream specials.

For each serving allow:

Fresh Peach Honey Sundae—Slice a half peach (nicely ripened) over serving of ice cream. Pour over this 3 tablespoonfuls warm honey and top with 1 tablespoonful honeyed whipped cream.

Honey Fruit Sundae—½ tablespoonful each of diced orange, pineapple, strawberry, Queen Anne cherries, bananas, fresh peaches (or any fruit one may have on hand), 3 tablespoonfuls warm honey, 1 tablespoonful honeyed whipped cream.

Honey Walnut Sundae—2 tablespoonfuls warm honey and 1 tablespoonful chopped walnuts.

Fresh Strawberry Honey Sundae—3 tablespoonfuls honey strawberries (as prepared for strawberry short cake.) Top with 1 tablespoonful honeyed whipped cream.

Basic Chocolate Syrup—1 cup honey, ½ cup cocoa, ½ cup hot water, 1-inch stick cinnamon, 2 tablespoons strong coffee, ⅛ teaspoon salt. Blend honey and cocoa together. Add the hot water and the cinnamon. Simmer for 10 minutes; cool, remove cinnamon, add coffee and salt. Cover and store in refrigerator until needed. It will keep indefinitely.

Uses of Basic Chocolate Syrup

Fudge Sundae—Dilute with whipped cream to desired consistency and of preferred chocolate favor.

Iced Chocolate—Dilute with a little warm milk, adding cold milk until of proper strength.

Cake Topping—Dilute with Honey Meringue. For flavoring confectioners' sugar icings.

HONEY IN COSMETICS.—

[Note—This article on "Honey Used to Produce Skin Beauty," is by Gladys Glad, "America's Famous Beauty."—Editor.]

Marie Jeanne Becu, a little French lass, was just a petite milliner in Paris, before the French Revolution. Marie Jeanne, however, knew men. She knew what wit and beauty could do to men. She cultivated both. And in time, she wound up as the famous du Barry, mistress of King Louis XV, and the most powerful woman of his reign.

Of course, not every girl can become a du Barry. We don't have kings in this land of the free. But modern man is just as appreciative of beauty as were those French lads. And modern woman is just as interested in making herself the queen of some man's heart as the famous du Barry was.

Madame du Barry, perfect as she was in every detail of beauty, believed a

woman's most important asset to be a lovely skin. This lass always took the most scrupulous care of her skin. And honey constituted one of the chief preparations that she used.

Honey has long been recognized as a true cosmetic. It is an ingredient of many fine creams and lotions today. And it is very nourishing and refining to the skin. However, I personally think that honey is much more effective as a skin beautifier when combined with other ingredients. A most effective honey lotion, for instance, can be made by blending one tablespoon of sweet almond oil and two tablespoons strained honey. This lotion should be used on the face after the skin has been thoroughly cleansed. It should be permitted to remain on the skin for about half an hour. Then it should be removed with a soft cloth and tepid water, and a mild astringent applied to close the pores and tone up the skin.

Honey also can be employed in making an effective face pack. To prepare this pack enough honey should be mixed well with a half cup of bran to make a smooth paste. If the paste seems too thick, a little rose water may be added to make its consistency smoother. Then the face should be cleansed, and the mixture spread generously over it. This pack should be permitted to remain on for 30 minutes. Then it should be removed with warm water and a soft cloth, and as the final step, a good astringent should be applied, in order to tone the skin.

Honey Pack Leaves Skin, Soft, Velvety

Honey packs are indeed beneficial for the skin, as they cleanse, bleach and soften it. To prepare the pack, add enough honey to half a cup of almond meal to form a thick, smooth paste. Cleanse the face thoroughly with a good cleansing cream, and after removing the cream, spread a bit of nourishing cream around your eyes and mouth. Then apply the paste generously over your entire face with the exception of your eyes. Permit the pack to remain on your face for at least half an hour. Then remove it with tepid water and a soft cloth. The procedure will leave your skin smooth and velvety.

Honey Mask for the Complexion—(Taken from the Boston Sunday Globe, September 14) —Mix a tablespoon of honey with a tablespoon of fine white flour; add a few drops of rose water, just enough to make the honey paste smooth and as liquid as you need it. Spread carefully over the face, let stay on half an hour, and then wash off with cold water, using a soft cloth Try this mask twice a week for a month. Result: youth back in the face.

Honey Facial, by Mme. La Faire—Honey, a beauty aid in our grandmother's day, is coming back into use and some of the beauty parlors are using it successfully in facials. First massage cleansing cream into your face and wipe off; then place a soft cloth dipped in warm witch-hazel over the entire face for five minutes. After this treatment dip the fingers into pure, strained honey, and pat gently into the skin until the entire surface has a good coating of honey. A treatment now of patting the face with the fingers, occasionally dipping them into the honey, should be kept up until the face tingles, then relax for about twenty minutes and then remove the honey with cloths dipped into warm water. Finish by rubbing the face with a piece of ice or cold applications of water.

Honey for Freckles—Half a pound of honey, 2 ounces of glycerine, 2 ounces alcohol, 6 drams of citric acid, 15 drops ambergis. Apply night and morning.

Balm of Gilead Salve—4 ounces mutton tallow, 1 pint balm of Gilead buds; 3 ounces honey, 1 ounce castile soap, 1 ounce rosin, 3 ounces beeswax, 1 ounce alum, 1 pound lard. Put the buds in a kettle with the lard and boil slowly for half an hour, stirring often. Strain and take the buds out. Put in the rest of the ingredients and cook slowly until done. This usually takes from one-half to one hour; excellent for chapped hands or lips, sores, or cuts, frost bites and piles.

Honey as a Softener of the Hands—Many are unaware that the very best cosmetics are made with honey as a prime ingredient. Here is one for the hands, which is said to be very fine. Rub together 1 pound of honey and yolks of 8 eggs; gradually add 1 pound of oil of sweet almonds, during constant stirring work in ½ pound bitter almonds, and perfume with 2 drams each of attar of bergamot and attar of cloves. Of course, the quantities may be reduced if necessary.

Honey Soap—Cut 2 pounds of yellow soap in thin slices and put into a saucepan with sufficient water to prevent soap from being burned. Place on the fire, and as soon as all the soap has dissolved, add 1 pound of honey and stir until the whole begins to boil. Then remove from the fire, add a few drops of essence of cinnamon, pour into a deep dish to cool and then cut in squares. It improves by keeping.

A Wax for Furniture and Floors—½ pound beeswax (or ¼ pound beeswax and ¼ pound paraffin). ½ pint turpentine, ½ cup alcohol. Melt wax in pan placed over hot water. Remove from fire and stir in ½ pint turpentine and ½ cup alcohol. Stir until mixture is a thick paste, pour into covered jar, and label. Apply small amount with a soft woolen or fine cotton cloth and rub until there is no free wax remaining on the surface of wood.—(Taken from Illinois State Beekeepers' Assoc., Bulletin, March-April issue.)

HONEYDEW.—Honeydew is a sweet glutinous liquid excreted in large quantities on the foliage of plants by Hemipterous insects, chiefly plant-lice and scale-insects. It is often so abundant on the leaves of trees and bushes that it drops upon the grass and sidewalks, covering them with a glistening coating resembling varnish. At times it falls in minute globules like fine rain. Although readily gathered by honeybees, it has an inferior flavor and is detrimental to beekeeping. The ancient Roman naturalist Pliny supposed that honeydew fell from

the stars, and this belief was generally accepted for centuries, hence the name. The honeydew gathered by bees is produced chiefly by five families of insects belonging to the suborder Homoptera of the order of Hemiptera or bugs; plant-lice (Aphididae), bark-lice or scale-insects (Coccidae), lantern-flies (Fulgoridae), jumping plant-lice (Psyllidae), and white flies (Aleyrodidae). A small amount of honeydew is also excreted by a few species of tree-hoppers (Membracidae), which are attended by ants.

Honeydew from White Flies

The white flies (Aleyrodidae) small winged insects covered with a whitish powder, were formerly classed with the scale-insects, as in their immature state they are scale-like in form. In warm regions they are reported to exude honeydew in large quantities, but in the temperate zone they are not sufficiently abundant to produce much of this excretion.

Honeydew from Jumping Plant-lice

The jumping plant-lice (Psyllidae) are small winged insects about one-sixth of an inch in length. Many of the species form galls. The pear-tree Psylla often destroys pear trees by sucking the sap from the twigs. According to Slingerland it excretes honeydew copiously. "It literally rained from the trees upon the vegetation beneath; in cultivating the orchard the backs of the horses and the harnesses often became covered with the sticky substance dropping from the trees. It attracts thousands of ants, bees, and wasps, which feed on it."

Hawaiian Honeydew

More than 400 tons of honeydew are shipped from the Hawaiian Islands annually, most of which is an excretion of the sugar-cane leaf-hopper (*Perkinsiella saccharidica*), a species belonging to the family Fulgoridae. In 1903 these insects became so abundant as to prove a serious check to the cultivation of sugar cane. For several years it caused a loss of about $3,000,000 annually to the planters; but it has been brought under control and today the plantations are again producing heavy crops of sugar. The honeydew from the sugar-cane leaf-hopper is described by Phillips as very dark amber in color and slightly ropy. In flavor it strongly resembles molasses. While most honeydews granulate very rapidly, this type does not granulate at all. Samples several years old are as clear as when first extracted. A small amount of this honeydew mixed with the light-colored algaroba honey imparts its color and flavor to the entire amount. Bees prefer floral nectar to the excretion; but, when the floral nectar is not abundant, they gather both and the honey is a mixture.

The chemical composition of Hawaiian honeydew honey differs so widely from floral honey that many buyers on the mainland have charged that it was adulterated; but after careful investigation Phillips was convinced that it was a natural sweet product collected by bees and shipped without the addition of other sugars. It is not placed on the market in competition with the honeys of the mainland derived from flowers but is sold to bakers who have found that it has superior baking properties and prefer it to algaroba honey. On the New York market it commands a slightly higher price per pound than algaroba honey.

Analysis (see table, page 439) of the honeydew honey of the sugar-cane leaf-hopper shows that the ash content is high, ranging from three to six times the amount found in normal honeys. The percentage of dextrin is also very high, and its acidity is three times that of algaroba honey. The percentage of sucrose or cane sugar is a little higher than that of the average of floral honeys. A ray of polarized light is turned to the right by the honeydew, while pure floral honey turns the ray to the left.

Honeydew from Scale-insects

The Coccidae are commonly known as scale-bugs, scale-insects, bark-lice, mealy-bugs, and Coccids. The species are very numerous and infest the bark and foliage of a great variety of plants and also nearly every kind of fruit. They excrete great quantities of honeydew both in temperate and tropical regions. Only the adult females exude honeydew. Not all of the species produce honeydew, as many excrete wax or resinous substances. In early autumn a great quantity of honeydew is occasionally gathered from oak trees, the limbs of which are covered with a great number of small Coccids, gall-like in form, about a quarter of an inch in length, from the ends of which there flows continuously a clear sweet liquid. So profusely is the honeydew exuded that the trees appear as though they had been sprayed with hundreds of gallons of it.

When it dries it solidifies and hangs in small stalactites. This honeydew is produced not by a gall, as is often reported, but by the adult females of a species of *Kermes*, which are remarkable for their gall-like form. "So striking is the resemblance," says Comstock, "that they have been mistaken for galls by many entomologists."

Species of Lecanium, a genus of Coccids found everywhere on plants, attack basswood, tulip tree, maples, and many other trees, covering the leaves with a sweet liquid similar to that yielded by plant-lice. In California a scale-insect (*Lecanium oleae*) coats the foliage of citrus fruit trees with great quantities of shining dew. A fungus often grows luxuriantly on such leaves, forming a dense felt over their surface. At Amherst, Mass., and at Guelph, Canada, thousands of bees have been observed gathering from spruce trees the sweet excretion of a scale-insect (*Physokermes picea*). They are found at the base of the new growth and have the appearance of little buds. Pine trees are likewise at times prolific sources of honeydew secreted by scale-insects living at the base of the leaves.

Honeydew from Plant-lice or Aphids

Probably more honeydew is produced by plant-lice or aphids (*Aphididae*) than any other family of insects. They occur on a great variety of trees and shrubs, a part of the species living on the leaves, a part on the limbs, and others on the roots. Among the deciduous-leaved trees on which honeydew is very frequently found are oaks, beech, popular, ash, elm, hickory, chestnut, maple, willow, basswood, gum trees, fruit trees, grapevine, currant, blackberry, and hazel. The aphids are so well known that they require only a brief description. They are small, thick, usually greenish insects with pear-shaped bodies and long legs. On the back of the sixth abdominal segment of Aphis and Lachnus there is a pair of tubes called cornicles. A part of the forms are winged and a part are wingless. In the fall both males and females appear. The females are wingless, but the males may be either winged or wingless. After mating, the males soon die; the females lay one or more eggs after which they die also. The eggs may often be found on the terminal buds of trees; e. g. on many of the terminal buds of the apple tree three or four minute black eggs are laid. Early in the spring the eggs hatch, but produce only females known as stem-mothers. By budding they give birth to living young instead of laying eggs. The second generation consists, like the first wholly of females, from which again come living offspring. Reproduction under these conditions without pairing may continue for eight or more generations, until with the approach of winter both sexes are again produced.

Plant-lice multiply with extreme rapidity and it has been estimated that the offspring of each plant-louse, if all survived, would in 100 days amount to over 3,200,000 individuals. Fortunately they are held in check by a vast number of parasitic insects, as syrphid flies, lady beetles, and plant-lice lions, or they would threaten the destruction of all vegetation. Their development is also probably greatly influenced by the weather. Occasionally there comes a year when plant-lice and scale-insects appear in hosts, and there is consequently a great abundance of honeydew, as in 1884 and 1909 in this country and 1898 and 1907 in Great Britain. In 1909 there was in eastern North America an unprecedented amount of honeydew, while the crop of white clover and basswood was almost a complete failure. Most of the honeydew came from the leaves of hickory and oak. While gathering it the bees were exceptionally cross. (See Bee Behavior, subhead What Makes Bees Cross; also Anger of Bees.) Since it became alternately partially liquid in the forenoon and gumlike in the afternoon, they were able to work on it only in the morning hours; the moisture in the air softened it at night, but by noon the sun again dried it to a viscous state. Honeydew honey is often stored by the ton, and in certain localities, as in the Sacramento Valley, California, a crop is gathered almost every year.

Honeydew, How Ejected

The dew is forcibly ejected or flipped from the end of the abdomen, and, when there are many aphids, falls in a spray of minute globules. If the dew were not thrown a little distance from their bodies they would soon be glued together. As they usually feed on the under side of the leaves, the sweet liquid naturally drops on the foliage beneath them. As it is gumlike it may dry and remain on the leaves for a long time, so that the absence of plant-lice is no proof that it is of vegetable origin. If it is very abun-

dant it may drip from the leaves to the ground. In 1891 Busgen observed that a single plant-louse on a maple leaf produced 48 drops in 24 hours (the drops were 1-25 of an inch in diameter), on a basswood leaf 19 drops, and on a rose leaf only 6 drops. The production of honeydew has been found to be most active in the middle of the day when the temperature is highest. The pair of tubes, or cornicles (also called siphons and nectaries) are commonly believed also to excrete honeydew; but this is denied by Forel and other entomologists, who assert that they exude only a gluey substance, which is not sought by ants. The tubes do not connect with the digestive tract, and the liquid which issues from them is produced by glandular cells at their base. In a part of the aphids the tubes are wanting or are greatly reduced in size.

Hemipterous insects of the families described live wholly on plant sap. The mouth-parts form a jointed beak consisting of four slender bristles enclosed in a jointed sheath, which is a prolongation of the lower lip. With this pointed beak the insect easily pierces the bark or leaf and sucks out the sap of the plant tissues. The jointed sheath permits of a change of position without the removal of the beak. A part of the sap is digested and is used for growth and the production of young, while the residue is expelled as a waste substance known as honeydew. It is thus undoubtedly an excretion which escapes by way of the anal opening. It may not, however, consist entirely of the waste products of digestion. MacGillivray states that in plant-lice, which produce honeydew abundantly, the posterior portion of the rectum is greatly enlarged and is lined with large active cells, which may excrete the honeydew. The objection to honeydew on the ground that it is an excretion rather than a secretion is largely imaginary as secretion is the more general term including excretion.

The Quality of Honeydew

The quality of honeydew varies greatly according to the plant on which it occurs and the insects producing it. When freshly gathered it may be clear, sweet, and agreeable in flavor, or at least not unpalatable. The better grades find a ready sale to bakers, who prefer it for baking purposes to floral honey. But usually it is very inferior in quality, for when it remains for days on the foliage it gathers many impurities. A black smut sometimes covers the leaves so that the extracted honeydew is inky black, resembling coal tar. This type might perhaps be used by manufacturers of blacking or of lubricants. It is not a safe winter food for bees. If the bees are left on the summer stands and can obtain frequent flights, they may winter in fair condition; but if they are placed in a cellar they will all probably perish from dysentery. For brood-rearing in the spring it is unobjectionable, and it is, therefore, advised that it be removed from the hives in the fall and sugar syrup fed in its stead.

Composition of Honeydew

The composition of honeydew honeys as compared with floral honeys is shown in the chemical analyses given in the table on this page.

From the table above it is apparent that honeydew honey contains less invert sugar, but more sucrose or cane sugar, dextrin or gums, and ash. It is because of the larger percentage of gums and ash that it is unsuitable for winter feeding. Honeydew honey may also be distinguished from floral honey by means of the

	Water	Invert sugar (Grape and fruit sugar)	Sucrose (Cane sugar)	Ash	Dextrin (Gums)	Undetermined	Free acid as formic
Floral honeys—							
Sweet Clover	17.49	76.20	2.24	0.12	0.45	3.50	0.12
White clover	17.64	74.92	1.77	0.07	0.82	4.78	0.06
Alfalfa	16.56	76.90	4.42	0.07	0.34	1.71	0.08
Honeydews—							
Hickory	16.05	65.89	2.76	0.78	12.95	1.57	0.12
White oak	13.56	55.87	4.31	0.79	10.49	4.98	0.08
Hawaiian sugar cane	15.46	64.84	5.27	1.29	10.01	3.13	0.15

polariscope. A ray of light passed through a solution of floral honey is turned or rotated to the left, but passed through a solution of honeydew honey it is turned to the right. If floral honey turns the ray to the right, it has been adulterated with glucose. No floral honey is obtained from the wind-pollinated flowers of hickory and white oak.

Besides bees, honeydew is attractive to wasps, ants, flies, and other insects. Bees pay no attention to plant-lice, but ants care for them and stroke them gently with their antennae in order to induce them to yield honeydew more freely. This behavior led the botanist Linnaeus to call Aphis the cow of the ants (*Aphis formicarum vacca*). Ants defend plant-lice from their enemies, move them to new pastures, care for their eggs, and build over them covers of earth or cowsheds to keep them warm. Ants also extend their protection to scale-insects.

The term honeydew should be rigidly restricted to the sweet excretions of insects gathered by honeybees. Nectar is the secretion of nectaries, whether floral or extra-floral. It has been asserted by many beekeepers and not a few botanists in the past, that there is a third sweet liquid, which, under favorable weather conditions is exuded directly by the leaves. The statement of Gaston Bonnier is often quoted to the effect that he had often seen trees on which there was not a single plant louse, covered with a sweet liquid which exuded from the leaves. Cowan, former editor of the British Bee Journal, gives this opinion. "We are perfectly aware that opinions are divided as to the source of honeydew; but we agree with those who think it generally is an exudation from the pores of leaves under certain conditions of the atmosphere, although it may sometimes be produced by aphids. We have on several occasions examined trees producing honeydew in abundance that were free from aphids." Many similar views might be given. But in the majority of cases it has been conclusively shown that the sweet liquid found on the foliage of trees is of insect origin, and that the assertions to the contrary were based on insufficient observation and superficial investigation.

Fir Sugar from Conifers

Recent investigations by Davidson and Teit, however, show that from the tips of the leaves of the Douglas fir in British Columbia, and Washington State west of the Cascades, there is exuded a sweet liquid in large quantities. "Fir sugar" was known to the Indians of British Columbia long before the discovery of America, and in recent years its presence has repeatedly been reported by beekeepers, but it does not occur every year. The sugar-yielding firs (*Pseudotsuga Douglassii*) are confined chiefly to the dry belt of British Columbia between the parallels of latitude 50 and 51 degrees and the meridians of longitude 121 and 122 degrees. The sugar is not formed on trees in the dense forest, but only on those in comparatively open areas, on gentle slopes facing the east and west, during hot summer droughts. In leaves of the Douglas fir exposed to continuous sunlight a larger quantity of carbohydrates is formed during the day that can be stored or carried away to the growing tissues. In the hot dry atmosphere transpiration ceases and the leaves become gorged with water, which is forced out through their tips. A beekeeper at Victoria states that many of the firs, particularly isolated trees, are well spattered with the exudation, and the needle-like leaves studded with pale amber diamonds. A large number of bees gather the liquid and in some years two of three supers of sections are filled with it. The honey is fair in quality, pale amber in color, with rather dark cappings. It crystallizes quickly. By the evaporation of the water the liquid is transformed into white masses ¼ inch to 2 inches in diameter. This solid may again be dissolved by rain and recrystallized in patches at the base of the tree.

A beekeeper living in the Olympic National Forest, Ore., 21 miles from Port Angeles, reports that his bees stored 150 pounds of fir sugar during a very dry season. The following winter many bees died from dysentery, which was attributed to the effects of the sugar. This seems very probable, as the composition of this excretion is very different from that of floral honey. It contains among other constituents nearly 50 per cent of the rare sugar, melezitose.

Honeydew from Leaves of Plants

It is certainly not improbable that other species of conifers may, under special climatic conditions, exude a sweet liquid. In Switzerland about 40 per cent of the honey crop is gathered from the weisstanne (*Piceae excelsa*), a fir tree. From an

excretion found on the leaves of this fir tree the beekeepers of the Vosges Mountains, the Black Forest, and in parts of Switzerland harvest large crops of "honeydew," also called "waldhonig." J. A. Heberle believes that this honey is of plant origin, since meteorological conditions seem to determine its production. Unfortunately most assertions that the leaves of coniferous and hardwood trees exude occasionally a sweet liquid are based on observations that are too superficial to be conclusive. But in the case of the Douglas fir the investigations of Davidson and Teit appear to establish beyond question the existence of such an exudation.

HONEY, DIASTASE IN.—See Honey, Enzymes in.

HONEY, ENZYMES IN.—Enzymes in various discussions under different heads in this work are occasionally mentioned. As the average reader, unless he is a chemist or a dietitian, may fail to understand what their function or purpose is, an explanation should be made.

Invertase is the enzyme which splits cane sugar (sucrose) while diastase splits starch. The usual name for an enzyme is the same as that of the sugar which it splits, with the exception that the ending "ose" for the sugar is changed to "ase" for the enzyme. According to this plan, the one which splits sucrose is sucrase, and the one which splits starch (amylose) is amylase. These two named are, however, exceptions to the general rule, because the names invertase and diastase are old and were in use prior to the formulation of the general rule. Many biochemists now prefer the terms sucrase and amylase and quite disapprove of the terms invertase and diastase. If one uses the term "diastase" for the enzyme which splits cane sugar, he is wrong under British or American usage. The French use the term "diastase" as a synonym for the word "enzyme," and for the French this may be all right. It is all wrong in this country or in Britain. The German usage is exactly like ours also.

The human stomach has one set of enzymes, saliva another set, various parts of the small intestine other sets, and their presence only starts the show of enzyme action. There are enzymes in the liver, the kidneys, the blood, muscles and everywhere that living cells exist, and each one or each set have special functions.

The enzyme, invertase, found both in the body of the bee and in honey, is not all used up in the ripening of the honey when first stored in the combs. This enzyme can and does continue to split any sucrose left not yet inverted into dextrose and levulose, or until the honey is fully ripe; but this enzyme, invertase, can not continue to work if the honey is overheated to a point that would kill the action of the invertase and right here it should be noted that a too high temperature on unripe honey will destroy the action of both the invertase and the diastase. A word of caution should be entered at this point: An unripe or thin honey (less than 12 pounds to the gallon) should never be sent to market, much less to Europe. To stop or prevent fermentation, it is the usual practice to heat the honey to kill the yeasts. (See Bottling of Honey, Granulation of Honey, and Honey, Science of.) The very act of heating, if carried too far, would prevent further inversion. An overheated honey, although fully ripe, if shipped to Germany, would probably be rejected because the action of the diastase had been destroyed.

This phase of the matter is covered by Dr. Geo. H. Vansell, of the U. S. Bee Culture Laboratory, Davis, California, in Gleanings in Bee Culture, page 370, 1929:

The apparent lack of weakness of the diastase in certain American honeys as compared with the German honeys is causing loss and worry to American shippers and producers at present. This "deficiency" has not hitherto been brought into the German trade relations, since some of the California exporters have never before encountered difficulty along this line in fully 30 years' shipping experience. Practically all of the investigational work with honey diastase has been done in Europe, particularly in Germany, in the literature of which we find reference to investigations as early as 1907.

Not all the deficiency in diastase activity can at present be explained on any theoretical or practical basis. Curtis & Tompkins, analytical chemists of San Francisco, have found the following diastase numbers:

Hawaiian honey (from a shipment which was rejected in Germany)	5.7
Comb honey from Belvedere, Calif......	Nil
A California honey from wholesale market	20.0
A Nevada honey from wholesale market..	11.8

The German investigators, Fiehe & Kordatski (Zeitschrift fur Untersuchung der Lebensmittel, No. 2-3, pages 162-169, 1928, Munich, Germany), show the number 8.3 for honey obtained by feeding bees sugar, while some of the locally produced German nectar honey had numbers up to 50. The pure food regulations in Germany now place any honey with a diastase number lower than 17.9 in a class suspected of adulteration or overheating, and demand rejection on any falling below 10.9. Since the same varieties of bees are now used in all commercial honey-producing countries, the variation can not be on account of different bees unless diastase content is an accident. Neither adulteration nor heating will explain the experience of two Fresno County (California) beekeepers, whose honeys were condemned after arrival in Germany in spite of the fact that they were pure

nectar honeys and were subjected to no artificial heat whatsoever. The comb honey from Belvedere, Calif., shown to have no diastase activity in contrast to the 8.3 for German sugar-fed honey, makes a strange case.

In the absence of the original German articles on this subject a method using the precipitated sugar-free honey enzymes was decided upon and tried at the California Experiment Station. The diastase and invertase may both be determined with the precipitate. This method is fairly satisfactory, but the resulting values of diastase activity are on a different basis from those set up in Germany. Since no trouble is encountered elsewhere it seems best at present to use indices already familiar there. A rough outline of a German method of procedure, largely according to Goethe and others, follows: 10 g. honey are dissolved in some distilled water, neutralized with n/20 sodium hydroxide and plenolphthalein as indicator (one titrates until the pink coloration remains preserved for several minutes), then add distilled water to make 100 c. c. The activity of the diastase is measured by its activity in this honey solution on a fresh 1% specially prepared starch solution. Twelve test tubes are filled with varying amounts of honey solution in a geometrical series.

For obtaining an optimal degree of acidity n/50 acetic acid solution is used in each test and for obtaining an optimal concentration of highly activating chlorine-ions n/10 sodium chloride solution is added in such an amount that even in honeys poor of chlorides the optimal activity is induced. The diastase number indicates the c. c. of the starch solution which are decomposed by 1 gram of honey during 1 hour's activity. The temperature of the test is maintained at 45-50° C. by a water bath, after which cooling is quickly effected by cold water or ice and then the characteristic colorations of the attained stages of decomposition are caused with 1 drop of n/10 iodine solution. The purple-colored tube is the deciding one. Those showing blue color contain starch.

Examples of values obtained by the German investigators follow:

No.	Honey.	Diastase No.
1	German heather honey from known local producer	50.
2	German tilia (basswood) from known local producer	38.5
3	German heather honey from distant unknown producer	29.4
4	German tilia from distant unknown producer which had been exposed to sunlight for about 4 months	23.8
5	Canadian honey from wholesale market	29.4
6	Cal'fornia salvia (sage) honey from wholesale market	13.9
7	Californ'a alfalfa honey from wholesale market	10.9
8	Valparaiso honey from wholesale market	8.3
9	Honey from bees fed on sugar	8.3
10	Jamaica honey	1.0
11	Honey of unknown origin	0.0

Attention is called to the apparent superiority of locally produced honey. No. 8 sample is stated certainly to have been heated, while Nos. 6 and 7 are strongly suspected of heating. Many of the tested foreign honeys (not shown in the above table), as we'l as some of German wholesale market honeys, have low diastase activ'ty, which is considered evidence of adulteration or of the application of heat. Diastase is considered of importance by these European workers, and those which have practically no active diastase are condemned in the regulations covering food sales.

Particularly active diastases are present in the salivary and other gastric juices of man. A definite statement as to the actual value to man of the relatively small amounts found in honeys would be hazardous. Diastase, of course, can be purchased in concentrated form to be added to a food when facts show such a practice to be feasible dietetically.

If pollen is the main source of diastase, then it is possible that German honey contains more of it than our American honeys or because we filter our product more than they do. We in this country cater to a clear honey that will sparkle in the sunlight. (See Honey, Filtration of.)

That the Germans have placed too strong a value on diastase in honey is evident. In the American Bee Journal, page 293, 1929, Dr. Vansell says:

> All beekeepers are probably familiar with the fact that the German Government has recently placed an embargo on honeys that failed to show, upon examination, a certain diastase content. Diastase is the name applied to enzymes or ferments that have the ability to break down starch into sugars. Inasmuch as honey contains very little starch and the amount of diastase in even the most heavily diastase-charged honeys is negligible in comparison with a small drop of human saliva, it seems certain that the objection to honey poor in diastase can not be based on the dietetic value of the diastase. Despite the fact that our investigations have shown some comb honeys practically devoid of diastase activity, German authorities consider any honey with a low or slow diastase content to be overheated or adulterated.

Practically all bottled honeys must be heated to a temperature of 160°F. to destroy primary crystals of granulation in order to prevent granulation. (See Granulation of Honey.) By the time the honey reaches the bottler, it is supposed to be thoroughly ripened and therefore not needing the further effect of invertase or diastase to complete inversion which is already complete.

As the presence or absence of diastase is in such small quantites it can have no effect on the flavor of honey or its purity.

Some work done by the U. S. Bureau of Chemistry and Soils Carbohydrate Division shows conclusively that there are some pure honeys in the United States that have little or no diastase notwithstanding that they have never been heated. It therefore follows that the presence or absence or even a deficiency of diastase in any given honey is not a measure of the purity of such honey. While it may be admitted that these factors may suggest that a honey has been overheated, the fact remains that very little of American honeys before they leave the producer in bulk are ever heated. With the exception of tupelo and sage the honeys are allowed to granulate before they are shipped in bulk, because there is less chance of leakage.

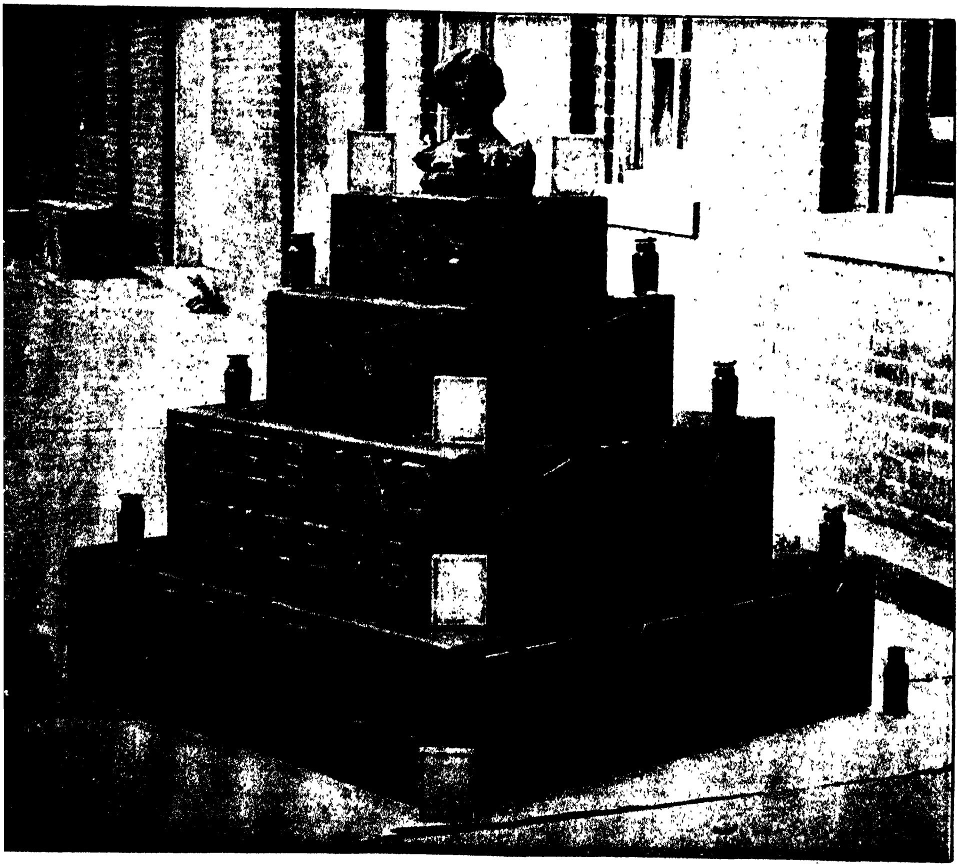
It is to be hoped that the German authorities, especially their chemists, will consult a paper by U. S. Chemists R. E.

Lothrop and H. S. Paine, entitled "Diastatic Activity of Some American Honeys."

Before leaving the subject it should be made plain that a temperature that will kill the action of diastase or invertase after inversion has been completed, need not necessarily affect the flavor, color or purity of any honey if cooled quickly thereafter. A continued high temperature does do damage. (See Honey, Filtration of, Granulated Honey, Bottling of Honey, and Honey, Science of.)

HONEY EXHIBITS.—Very much indeed has been accomplished by the exhibits of bees, honey, and apiarian implements at state and county fairs. Several of the larger fair associations have had very pretty buildings erected on the fair-grounds for these displays.

Such exhibits have a decidedly educational influence on the public. They show how beautiful honey is; how it can be produced even by the ton and carload. On account of newspaper yarns, which were current some years ago and which still appear from time to time, there is still a belief among some housewives that comb honey is manufactured, and that the extracted article is adulterated with glucose. It is hardly necessary now to say that it is impossible to manufacture comb, fill it with honey, and "cap it over with appropriate machinery"—just as impossible as it is to manufacture eggs. The publishers have had for many years a standing offer of $1000 to any one who would show where comb honey was manufactured, or even procure a *single manufactured sample* which could not be told from the genuine. Although this offer was published broadcast in the daily papers, no one took it up. The conditions of this offer were printed on a neat little card,



Suggestion for a beeswax exhibit at state fairs.

which has been distributed by beekeepers at fairs and other honey exhibits, so that, if such a thing had been possible, the offer would have been taken up. As to extracted honey, there was a time when it was adulterated somewhat, but owing to the action of state and national laws there is very little of it now. (See Adulteration of Honey, also the last paragraph on Honeycomb.)

Beekeepers, besides educating the general public as to the *genuineness* of their product, can create a larger demand for honey. As a usual thing, exhibitors are allowed to sell their honey, distribute circulars, and do a great deal of profitable advertising. This not only helps the individual, but helps the pursuit in general.

The accompanying engravings will give an idea of how model exhibits should be arranged.

There should be shelving arranged in the form of pyramids, octagons, and semicircles. The honey should be put up in tin and glass, in large and small packages, and the whole should be neatly "set off" with appropriate labels. As a general thing, glass packages should have a very small label, so that as much of the liquid honey as possible will show. Tin receptacles should have labels to go clear around the can. Comb honey should be put up in cartons and shipping cases; and yellow cakes of wax should be shown in a variety of shapes.

In one of the illustrations will be seen a large pyramid of beeswax, supporting on its several shelves packages of honey, the whole surmounted by the bust of a goddess. A series of square shallow boxes are made of such sizes that, when piled one on top of another, they form a perfect pyramid. These are completely covered with sheet wax having the edges that come in contact nicely cemented together with a hot iron. The letters are cut out of inch boards with a jigsaw, after which they are dipped in hot wax, and secured with nails to the pyramids. The next thing to make is the goddes of liberty, or the bust of a prominent man. These in plaster can usually be purchased at any of the stores for a small sum of money, and, after being dipped in hot wax, give a very fine wax figure.

Besides the exhibit of honey in various

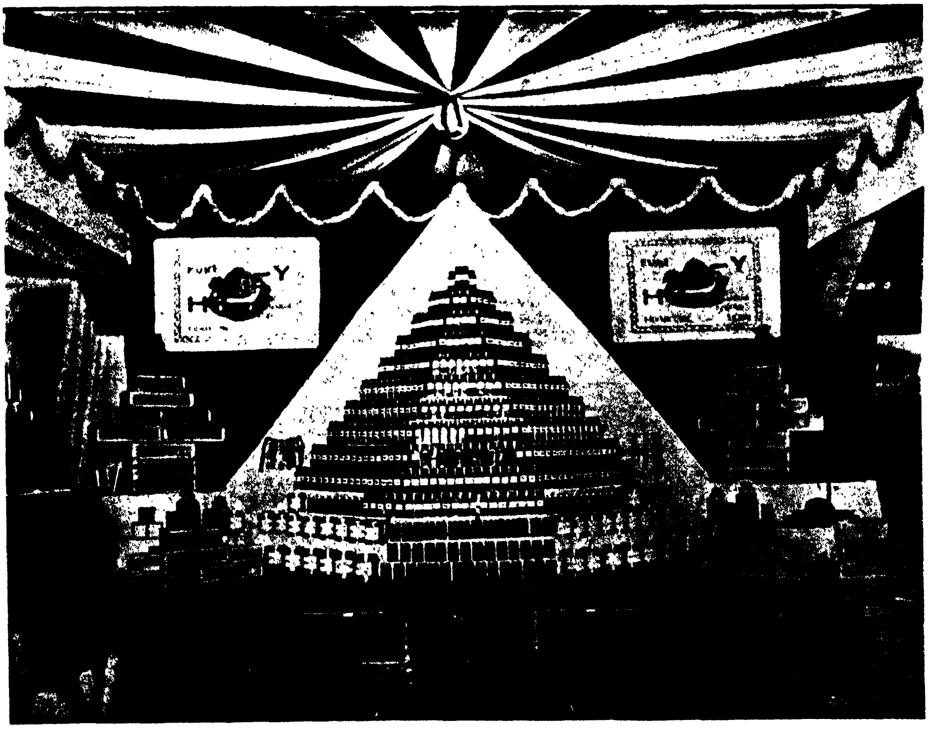
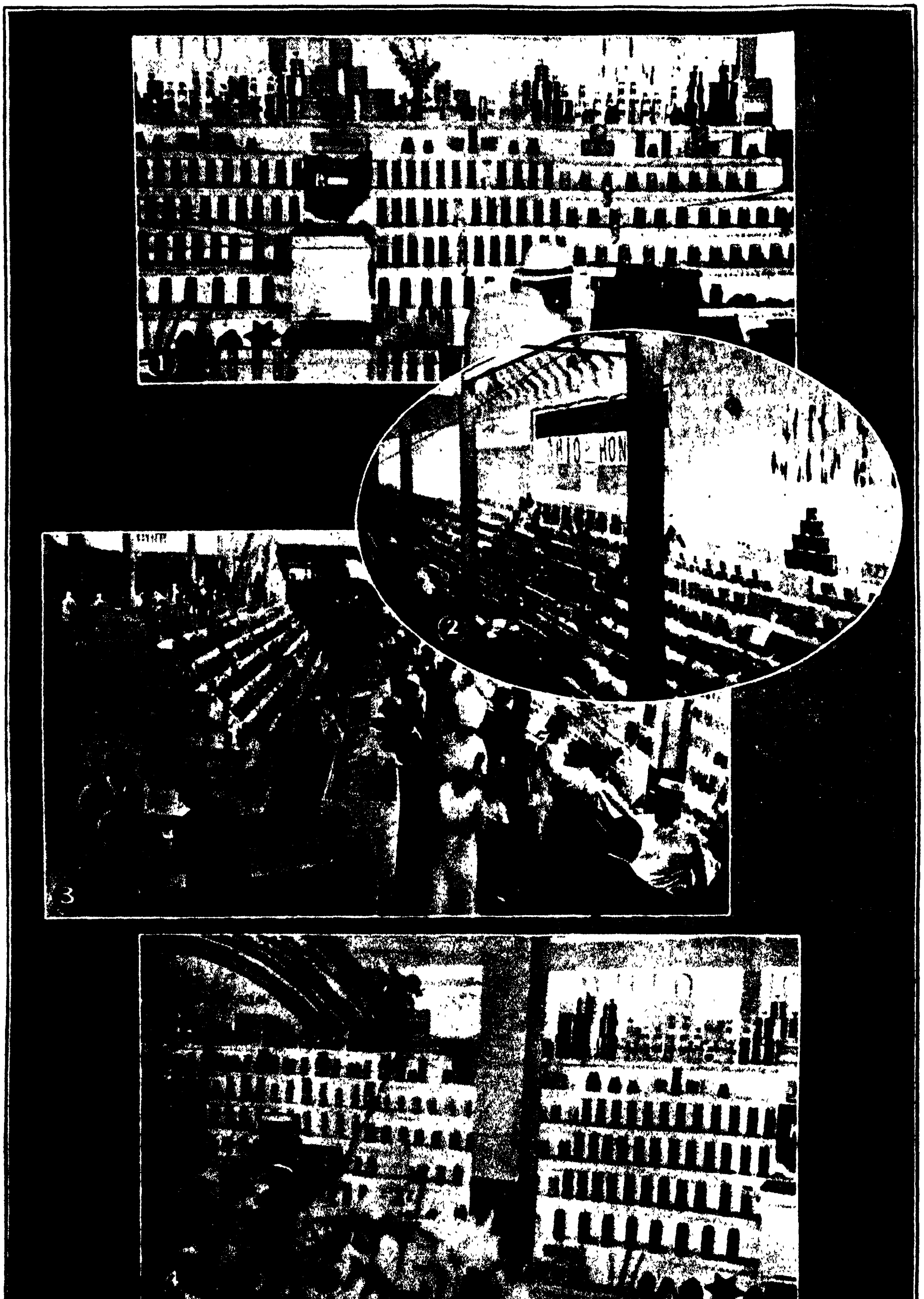
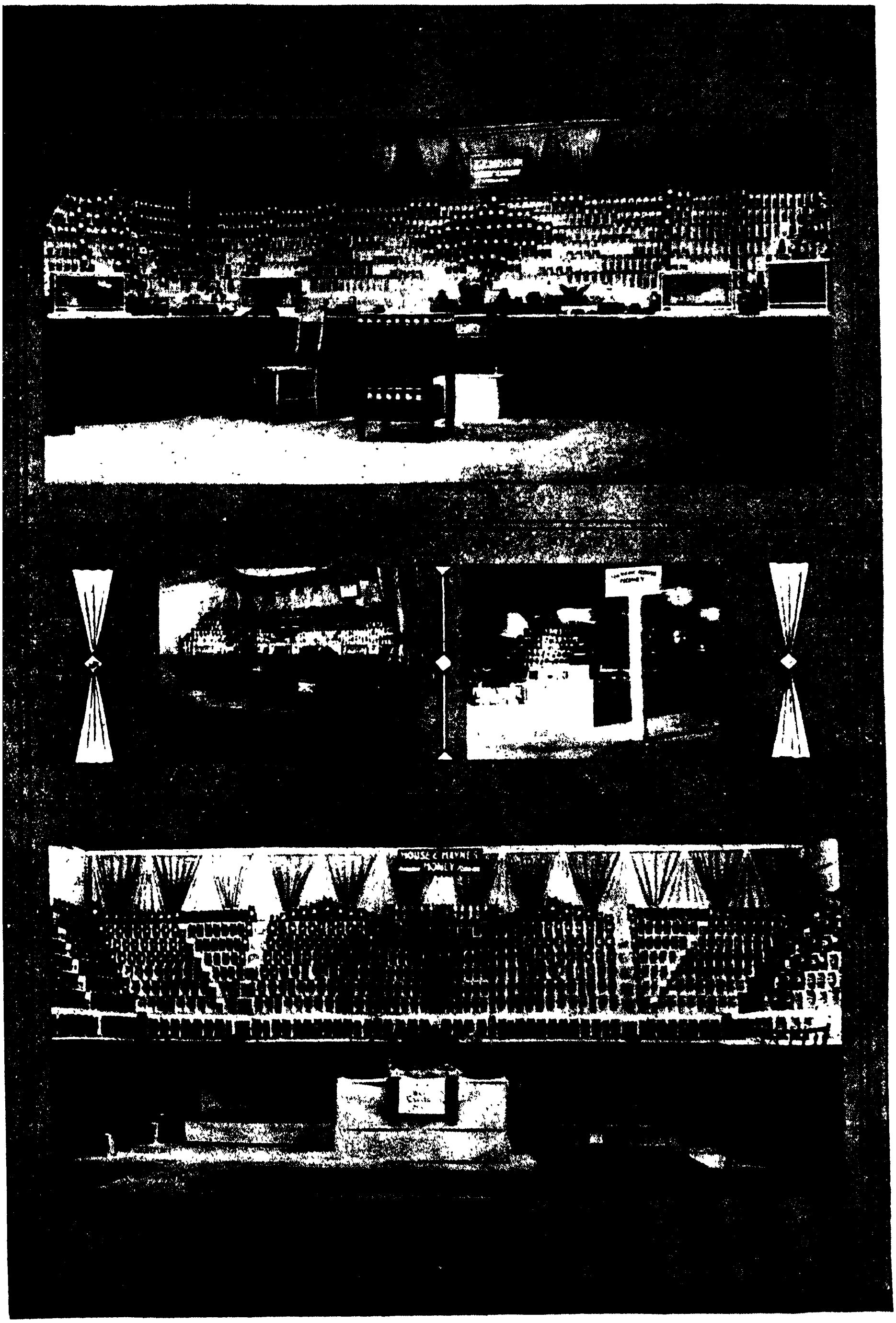


Exhibit of J. M. Buchanan, Franklin, Tenn., at Tennessee State Fair, Nashville.



HONEY EXHIBITS AT THE OHIO STATE FAIR.

1. Part of exhibit by I. P. Vandevier, Medina, Ohio. 2. Exhibits from left to right: H. D. Hyatt, Columbus, Ohio; E. T. Keil, Mars, Pennsylvania, apiaries near Findlay, Ohio; Geo. Thompson, Fremont, Ohio. 3. Part of honey exhibit by the Ohio State Beekeepers' Association, where over $100 worth of honey was sold, and over 7000 honey recipes were given out during fair week. 4. Exhibits from left to right: Carl Hurst & Sons, Williamsport, Ohio, who won the sweepstake prize, and a part of the exhibit in (1) above.



Top—The Lundin display, which took first premium. Left Center—E. F. Parker's exhibit. Right center, Florida Honey Distributors' exhibit occupying the center of the building. Bottom—House & Haynes' exhibit, which took second premium. The lighting effects in all of these exhibits were very fine. These exhibits were shown at the Florida State Fair, 1933.

styles of packages, there should be a collection of bee-supplies, so that when the interested persons come along with their string of questions, they can be shown step by step the process of producing honey and its final putting-up for market. A good many questions will be asked in regard to the extractor. It will be called a churn, a washing-machine, and everything else except what it really is. This should be explained. There should be one or more observation hives to show how bees behave when at home, and particularly the queen.

Very much can be done by having a glass hive and live bees, with an entrance communicating outdoors through the sides of the building where the exhibit is made. What is equally good, or perhaps better, is a one-frame nucleus having glass sides, making, as it is called, an observation hive. This should contain one frame of nice brood, regular and perfect comb, finely marked bees, and a bright-yellow queen. Hundreds of people will stop and examine, and ask a variety of questions about the bees and queen.

Bees in an observation hive will stand confinement for two or three days but not longer. Ordinarily at fairs and other places, where the show lasts only two or three days, the confined bees will do very well. But at expositions, where they are shown week after week, it is necessary to give them a flight every day.

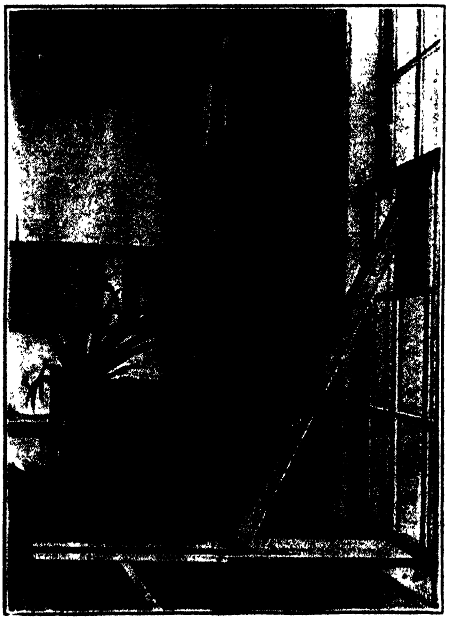
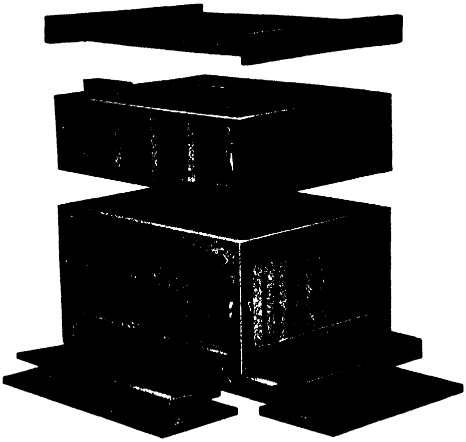


Fig. 1.—Single-comb observation hive with tube at entrance, throwing flight of bees above heads of passers-by.

This can be accomplished most successfully by running a wooden tube or chute from the hive to the outside wall of the building.



Observation hive with comb-honey super.

The bees will very quickly accept this long runway to outdoors as shown in Fig. 1. This tube should be much longer than here shown. In fact, it should reach the top of the window, or perhaps better the very top of the room and thence to the outdoors. The flight of the bees on the outside to the tube should be at least ten feet above the heads of pedestrians. If there is no immediate sidewalk or street close to the wall of the building it is not so necessary to put the outside entrance so high up.

The author has used an outfit as shown in Fig. 1 for several seasons, the entrance opening up about twelve feet above the sidewalk in front of the store where honey is for sale. As a precaution gentle bees with a yellow all-over queen should be selected so that her majesty can be easily located.

The outfit here shown has been used summer and winter for several years with the best of satisfaction. About once a year the bees and queen are replaced because a constant temperature summer and winter wears out the queen in egg-laying, and moreover the bees do not winter as well in a warm room as they do in a temperature colder where they can go into a winter sleep. (See Wintering, subhead, Cellar Wintering.)

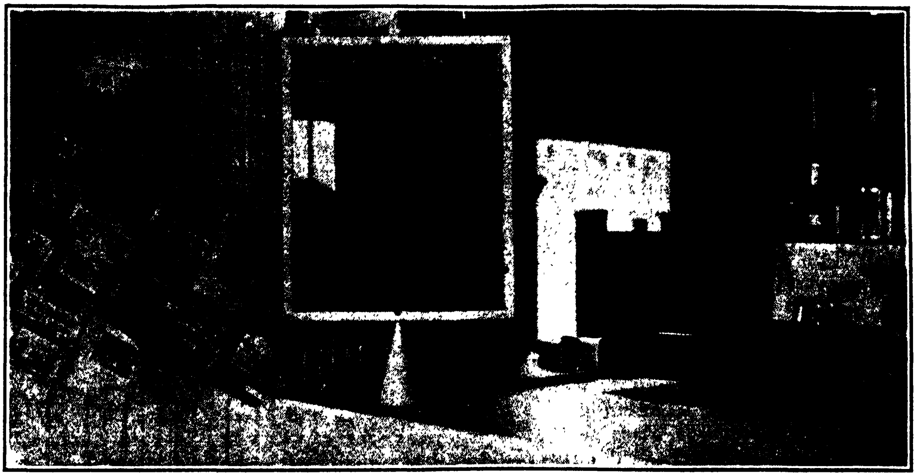


Fig. 2.—Two-comb (one above the other) observation hive pivoted to permit rotating.

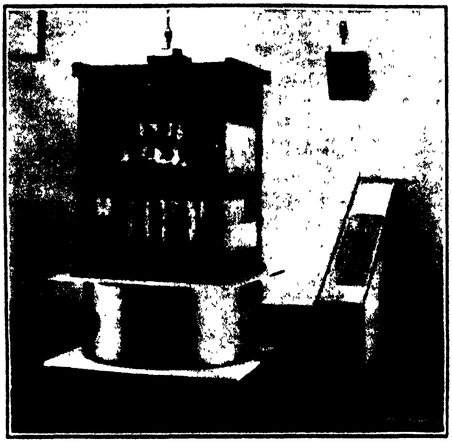
A much better arrangement but more expensive and a little more difficult to construct is shown in Fig. 2. This as will be seen is a two-story observation hive having only two combs, one above the other, with four sections on top. The whole is mounted on a pivot with a corresponding hollow pivot at the top connecting with a tube or chute that reaches to the outside of the building. There is no reason why the chute could not be put at an angle so that the entrance could be at a higher level.

The principle of a revolving hive makes it possible to see one side or the other by turning the hive on its pivot. This is quite

The split observation hive is an excellent means of attracting attention to honey in display windows or in exhibits of honey at fairs. This is made out of a common hive sawn into two halves. Two large sheets of glass cover the two halves.

important in that it enables the observer to place the glass front at such an angle to the light that it does not throw back a looking-glass effect, obscuring a clear vision of the bees, the queen and the comb. Where the hive is stationery, as in the other, the reflecting light often makes it difficult at certain hours of the day to see the bees or the queen clearly.

At the Century of Progress at Chicago during 1933 and 1934 there was on display a full colony of bees at work in a two-story glass hive. This was mounted on a constantly revolving turntable, on the underside of which in the center there was an opening that led to a boxed runway about six inches square, leading to the outside wall of the building. The top of the runway was of glass so that the bees going and coming from the hive could be plainly seen.



A full two-story and a half colony of bees living and prospering in a hive with glass sides and ends as was shown at the Century of Progress Exposition during the summers of 1933 and 1934. The hive constantly revolved at slow speed so that all sides could be seen. The bees found access to the outdoors through the bottom connecting with a glass chute to the outer wall of the building.

This colony continued through the two seasons, prospered and stored honey as if it had been outdoors. The bees could be seen at work through the sides and ends in the hive revolving at slow speed.

There was no complaint of any one getting stung, nor was any concession selling candies, fruits, or soda water annoyed by the bees. The constantly wetting down of lawns of the exposition kept the bees busy on the white clover present, and the sweet clover surrounding the grounds also was a good source of nectar.

The Advertising Value of Observation Hives in Show-windows of Groceries and Drugstores

In the fall, when the active selling season for honey naturally starts, a beekeeper can very often place to advantage a single-comb observation hive in the show-window of groceries and drugstores where his honey is on sale. (See Observation Hives.) The presence of live bees, the honeycomb, the sections just above, in addition to their educational value to the general public, call attention to the honey on sale in the window as nothing else can. The sidewalk will very often be blocked by crowds to see the "king bee," as they call it, and the bees making honey. When both comb and extracted are displayed in packages of various sizes in show-windows along with the exhibit of live bees the bystander will naturally step inside and buy a package of honey. The first package will taste so good that it will call for another and another.

The advertising value of live bees at fairs and expositions can scarcely be overestimated, especially in localities where such exhibits have never been made before. When sales of honey are once started they will keep on and on. (See Marketing Honey; also Bottling Honey.)

Live-bee Demonstration Work to Advertise Honey at the Fairs

In connection with an exhibit inside of a building, there should be a placard directing the visitor to a bee-show outside, as near the building as possible. This should be a demonstration in a wire cage, of the method of handling live bees, the operator taking them up by handfuls and forming artificial swarms. Where the two exhibits, one of honey and bee-supplies, and the bee-show itself, can be located outdoors, it will be better. The former should then be in a temporary booth or tent, since it would not be advisable to have the exhibits of wax and comb honey exposed to the direct action of the sun. The demonstrating cage should be located close by, within ten or twenty feet. It consists of a wire-cloth structure large enough to take in a man, a hive of bees, and room enough to practice ordinary bee-manipulations. This cage should be elevated on a stand four or five feet above the ground—the higher the better, because there will be a great jam of people around to see the man inside pick up live bees by the handful.

Announcement should be made from outside of the cage that, during certain hours, an operator, bareheaded and barearmed, will perform some wonderful stunts in handling bees. When the performance begins, the people will surge around the stands, and that is just what is desired in order to sell honey at the other stand a few feet away.

The operator begins his performance by stepping inside the cage of live bees, and closing the door. He then tells the crowd that he is going to handle live bees, every one of which is armed with a sting; and if any one doubts it to come forward and he will furnish "proof." He proceeds to take off his coat and vest and roll up his sleeves, takes off his collar, and tucks down his shirt-band. It will then be necessary for him to put on bicycle pants-guards, or slip his trousers into his

The author in the center has shown W. F. Matthes at the Kansas State Fair how to grow whiskers. A caged queen was placed on his chest under his chin. Her bees were shaken on to a newspaper and then were caused to slide onto his chest and shoulders. Several newspaper lots of bees were thus dumped until the effect here shown was accomplished. Mr. C. Denny on the right assisted.

stockings. The crowd will quickly appreciate this part of the performance, because the operator tells them the bees will sting if they get inside of his clothing. With a lighted smoker he opens the hive. After pulling out the frames he shows the bees and queen on the comb; then he calls out for everybody to wait and see the next stunt, for he is going to make a swarm. Into a large newspaper spread out flat, which he has previously provided, he shakes the bees from two or three combs. Then he takes it up and turns to the crowd, saying, "The bees are not real mad yet, so I'll begin to shake them up to make them so." He now gathers the four corners of the paper together making a fold in the middle. With a quick jerk downward a couple of times he shakes the bees down in the crease or fold of the paper. Next he turns the paper so that the fold or crease will stand vertically over a common hat. Two more quick jerks downward will send the bees in the fold of the paper pell-mell into the hat. There will be from half a pound to a pound of bees in the hat, crawling over each other as a little swarm. If the work has been done right they will be so disconcerted that they will be perfectly docile and can be picked up by the handful. Shove one hand down gently into the cluster of bees, with the fingers placed in contact from end to end. The movement should be *very slow* so as not to pinch or crowd the bees. A quick shove will subject the hand to several stings, and spoil the whole demonstration.

The hand should be shoved under the cluster, being careful not to pinch or push, until a good handful is secured. Gently lift the hand, displaying two or three hundred bees. Ask members of the audience if any of them wish to "shake hands." As no one volunteers, it provokes a little fun. To dislodge the bees, give one quick jerk of the handful of bees over the hat. If all do not drop off, a second shake will dislodge every bee.

By this time the bees will have crawled over the hat—on the inside of the hatband and on the brim. Lift the hat up and suspend it over the head. A few dozens or hundreds may fall on the head. These will not sting if the operator does not get nervous. Let the hat down upon the head, very, very gently, taking a full minute to do it. The slow movement will gently crowd the bees away so that none

will be pinched between the crown of the head and the hat-band in the hat. If the hat be let down quickly it will pinch some bees and these pinched bees will sting as sure as fate.

There is no danger either from taking up a handful of bees or from putting a hatful of them on the head if the movements are deliberate enough. A little practice will make the demonstration a thriller—one that will draw crowds if repeated at intervals, as announced.

The author was once challenged to handle the crossest bees in the state of Ohio. They were described as the worst stingers that could be found; that no one could even approach the hive without getting stung.

When the bees were brought to the stand they stung viciously; but when they

The author with a hat full of the "worst stingers in Ohio" on his head. He was not stung.

were shaken on the newspaper and from the paper into the hat they were "as gentle as kittens," as the illustration shows.

At the next performance there will be big crowds around to see the work. While the man is doing his stunts with the bees he tells what honey is, saying there is no such thing as manufactured comb honey, and that he will pay $100 for a single sample of it. At the psychological moment he draws attention to the fact that he has some good honey at the stand opposite or in the building yonder. The crowd will then go round to the stand and buy the honey.

After the exhibitor gets his questioner interested, he can hand out one of his advertising cards, and at the same time give him a little sample of honey to taste. This can be done very readily by handing out some small strips of wood which are to be dipped in the honey and then transferred to the mouth.

HONEY, FILTRATION OF.—There are three general methods by which honey can be clarified, either in part or in whole. First, by filtration; second, by gravity or sedimentation; and, third, by a combination of the two.

Plan No. 1 is described in part under Extracting, page 273. However, it has been the usual practice, first, to use two or three thicknesses of wet cheesecloth spread over a light framework mounted on a tub to receive the honey, or, second, to spread the strainer cloths over a tank direct. The cloths, in either case, should bag down in the center and then fastened with a string wound around near the top of the crate or can, and tied. The first is here shown.

The second, or tank filtration, is shown at the right of illustration, on page 263, under head of Extracting. The strainer cloths should bag down to within a few inches of the bottom of the can, but should not touch the vertical sides for reasons that will be explained later. (See Fig. 5.)

Still another plan is that of supporting the strainer cloths on an inverted cone of

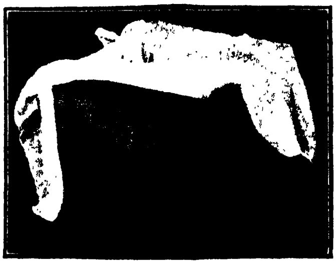


Fig. 1.—A straining outfit using a wooden frame.

coarse-mesh wire cloth, as shown next in Figs. 2 and 4. The cone is held by lugs hooking over the side. This has the merit that when the strainer cloths are clogged with sediment they can be easily removed and clean ones put in their place.

A hot or warm honey will pass more readily through cheesecloth, or a filter, than a cold honey. The same is true to a lesser extent of a relatively thin cold honey. Usually three thicknesses of wet cheesecloth are about right. Why wet? Because it will take some time for a honey, hot or cold, to pass through dry cloths. The cloths should first be immersed in water and then wrung nearly dry before attempting to pass honey through them.

Fig. 2.—A honey straining outfit for the larger beekeepers.

It is important that the strainer cloths be renewed often as they will soon clog with sediment so that the honey has difficulty in passing through. It is a simple matter to wash them in hot or warm water, when they can be used again. Frequently renewing with fresh cloths will greatly facilitate the process of straining honey.

It is very important also that as the honey passes through the strainer, it should not fall in little streams a distance of several inches through air space because in so doing these little streams will carry down with them thousands of minute air bubbles into the body of the honey. It is these same air bubbles that make the honey look cloudy when put up in bottles. It is very important, therefore, in running the honey through strainers in the manner described that the streams of honey either fall on an inclined plane, or are caught on a funnel just under the strainer where the cloths rest on an inverted cone of coarse wire cloth, as shown in Figs. 2 and 4. The following diagram, Fig. 4, will show how this should be accomplished. The funnel should be separated from it in the hook-up by about an inch, or close enough so that the honey as it oozes through the strainer cloths will not gather air in its downward fall. The funnel catches the honey when it flows by gravity over a smooth surface into the spout of the funnel and this spout should be on a slant and long enough to extend down into the honey near the bottom of the tank, The strainings will cling to the spout and finally pass into the strained honey below without carrying air bubbles large and small. The coarse-mesh wire cloth funnel should be detachable and separate from the funnel of solid metal. The latter should be hooked on first over the top of the tank, as shown in Fig. 4. On top of this and an inch above it should be set the coarse-mesh wire funnel and over this the several thicknesses of cheesecloth. The number of thicknesses should be adjusted to the temperature of the honey and its density.

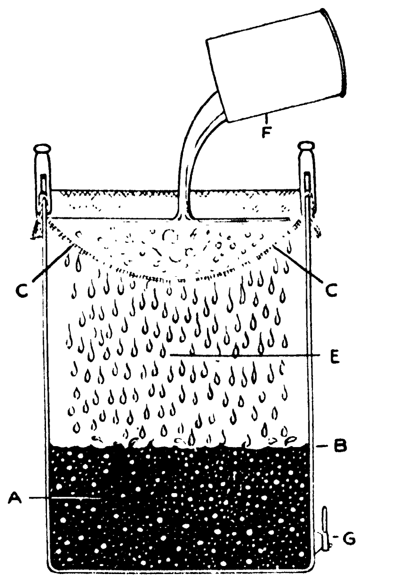


Fig. 3.—The wrong method of straining honey.

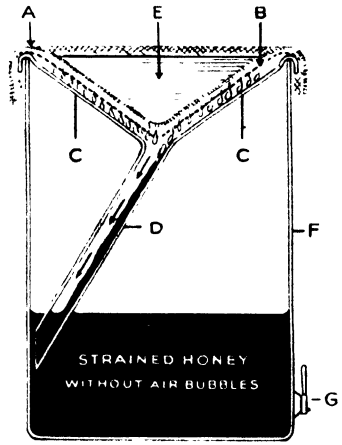
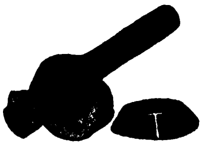


Fig. 4.—The right method of straining honey.

Strainer for a Small Beekeeper

A much simpler strainer for the amateur, or small beekeeper, can be made of a large size second-hand lard can and several large squares of cheesecloth. Into the bottom of the can should be soldered a honey gate. The squares of cheesecloth,



A honey gate with a V-shaped lip to regulate the size of streams.

two or three thicknesses, should be large enough when spread over the top of the can to push down to within two or three inches of the bottom of the can, leaving a clear space between the bag and the vertical sides of the can. When properly adjusted, clothespins pushed over the top of the cloths and the top rim of the can will hold the strainer in place.

This cheaper outfit, Fig. 5, like the other in Fig 4, avoids having small streams of honey from the strainer fall a distance through air space, carrying with it air bubbles into the strained honey. A

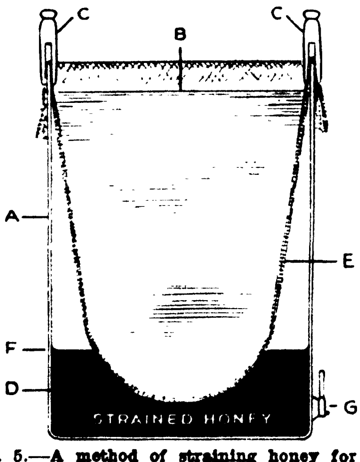


Fig. 5.—A method of straining honey for the small beekeeper.

separate funnel is not needed because the relatively deep bag of cheesecloth extends down into the strained honey. The honey on the vertical sides of the bag will ooze through the strainer cloth and flow down into the honey that has already been strained without carrying down particles of air.

But it should be clearly understood that this strainer will not work if the honey that has gone through the strainer is equal in height or level with the honey in the bag not yet strained. The pressure will be equal on both sides and, of course, the filter can not work until the filtered honey has been drawn down through the honey gate to the point F, or below, in Fig. 5. One can, if necessary, draw off the honey into bottles as fast as the strained honey oozes through the sides of the filter bag; but remember this, don't let the filtered honey rise above or below F in Fig. 5.

Honey Should be Hot to Filter Well

While cold honey may in time pass through either one of the strainers just described, a warm, or better, a hot honey (not hotter than 160° F.) will go through much more rapidly.

Filtration by Gravity or Sedimentation

Plan No. 2 has already been described in part under Extracted Honey, on page 251, and again under Extracting on page 273. The basic principle of this method is that air bubbles, large and small, bees' wings, legs, or hairs, pieces of comb, and particles of foreign matter, are lighter than the honey itself. If the honey, after extracting, is run into relatively tall tanks and allowed to stand in a warm room for several days, or perhaps, weeks (depending on temperature), the air bubbles and foreign matter will rise to the top in the form of scum when it can be skimmed off. During summer, especially during July and August, sunlight from several windows will make a closed room warm enough for sedimentation. The honey below the surface, especially that near the bottom of the tanks, should be relatively clear, when it will be ready for market.

The process of sedimentation can be greatly hastened by heating the honey to about 130°. But here is both a difficulty and a danger. The cost of heating the honey in a tank by means of coils submerged in the honey and through which hot water is made to pass, is considerable. The danger is in overheating and heating the honey unequally and in impairing both the color and the flavor. If care is taken, however, there will be no damage to the honey. For a simple means of heating honey, see pages 102, 103, and 104, under head of Bottling Honey.

Plan No. 3, a combination of No. 1, straining through cheesecloth, and No. 2,

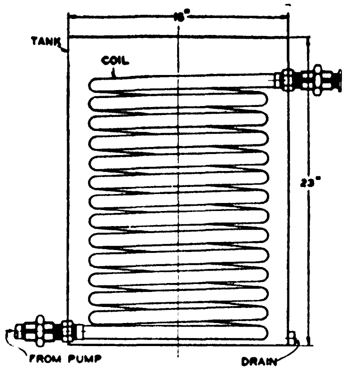


FIG. 4

Fig. 6.—Hot water coil for heating honey in a tank.

sedimentation, obviously is to be preferred to either one alone. When the honey is warm just from the extractor, it should be passed through a filter, or cheesecloth, before being pumped into storage tanks, by either of the two methods shown in Figs. 4 and 5, to remove the dead bees, larvae, bees' legs, wings, and coarse foreign matter. There will then be left small particles of foreign matter and some small air bubbles that cause cloudiness in the honey. These should be removed as far as possible by plan No. 2, or the gravity method already explained.

Removing Cloudiness in Bottled Honey

After honey has been clarified by any, or a combination of, the methods just given, it may still show some cloudiness after being put in bottles. This slightly milky color, if present, as has been explained, is due to very minute air bubbles not yet removed by straining through cheesecloth or by sedimentation. Perhaps the honey was too cold or not kept long enough in the gravity tanks to remove the bubbles. This cloudiness can be removed by placing the bottles with the caps loosely screwed down out in the hot sun for several days. The cloudiness will gradually rise and finally disappear. In mid-summer with plenty of hot sun to warm up the bottles, the bubbles will quickly rise to the surface and disappear. The caps should then be screwed down.

If the weather is cold and little or no sun, a hot room of about 100° F. will do nearly as well. Honey in bottles stacked around a hot stove or over a furnace register for several days will clear up in the same way. If later on this honey should show granulation, the bottles can be put in trays in water heated to 160° F. and kept there until the granulation disappears. This method of restoring the honey to a liquid condition would be practicable only for the small beekeeper who desires to give his customer a liquid honey.

It is always a mistake to leave honey that has begun to show granulation on the grocery shelves. The prospective buyer, the housewife, sees it and concludes that the "stuff" is "going back to sugar," and does not purchase. The local producer can easily correct this by the plan just outlined.

Filtration of Honey as Worked Out by the Bureau of Chemistry and Soils

In the Carbohydrate Division of the Bureau of Chemistry and Soils, Washington, D. C., H. S. Payne and R. E. Lothrop in 1934 and 1935 worked out a method of clarification of honey that goes further than those just described in that it makes the honey crystal clear, so clear that reading matter placed back of a bottle of it can be read easily. Instead of cheesecloth or a metal seive employed by beekeepers, or of gravity tanks, the principle is quite different. It is called the rapid or flash method. It consists in intimately mixing a small proportion of an inert filter aid (a sort of clay) with the honey, after which it is pumped through a metal coil immersed in water, the temperature of which is maintained at the desired point (140°-160° F.). After the honey is heated, it is forced from the coil into an enclosed filter press, which is maintained at approximately the same temperature so that the honey is prevented from cooling when it enters the filter. Upon emerging from the press fifteen minutes after the work was begun, the honey, crystal clear, is ready for bottling. During the filtration the added filter aid is removed and with it particles of suspended matter and minute air bubbles which, as has already been pointed out, are the common cause of cloudiness in the honey. The diagram on the next page will show the method in detail.

It has been found by experience that in municipal water filtering plants a turbid or muddy water will filter better than one relatively clear. Taking advantage of this principle an inert clay in the form of a special filter aid when mixed with honey will help materially to pick up the foreign matter held in suspension and when the two, the clay and the sediment including

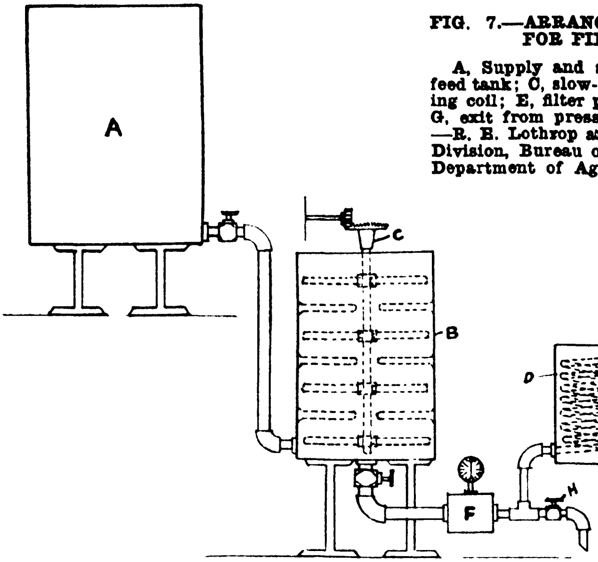


FIG. 7.—ARRANGEMENT OF EQUIPMENT FOR FILTERING HONEY

A, Supply and settling tank; B, mixing and feed tank; C, slow-speed mixing device; D, heating coil; E, filter press; F, rotary honey pump; G, exit from press; H, valve for draining cell. —R. E. Lothrop and H. S. Paine, Carbohydrate Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

air bubbles, are thoroughly mixed they both will be caught better in the filter than if the sediment and air bubbles were alone.

The filter press of special construction requires pressure. The other filters described at the outset use only gravity. This one shown in Fig. 7 is made up of a series of frames between which there is a special fabric or cloth. The whole is clamped together by bolts, as shown, and when the cloths become foul or clogged with foreign matter the press can be taken apart and cleaned. These presses can be obtained of T. Shriver & Co., Harrison, N. J., or Cellulo Co., Sandusky, Ohio.

This plan of filtration as put out by the Bureau of Chemistry and Soils was published in all of the bee journals for December, 1934, and further amplified in Gleanings in Bee Culture for July, 1935. The plan is not given in full here because very few of the readers of this work will be able to use it, first, on account of the expense, and, second, on account of the necessary skill to operate. A full description of the method can be obtained of the Bureau of Chemistry and Soils.

Since this method was put out, beekeepers have clamored for a cheaper and simpler plan involving less cost for apparatus and this has been given in the matter preceding.

Again, experience has shown that in some cases the housewife is suspicious of a honey that is so crystal clear. It is not like the honey she has bought before. One large bottler has for this reason discontinued the government plan of filtration.

Some of those who have tried it have carried the process too far, making only a simple invert sugar syrup without flavor and lacking some of the essential elements that go to make up a real honey. Such honey would not meet government standards. In other cases, the filter aid, on account of a lack of skill, was allowed to go through the filter. If directions are followed carefully this will not happen.

The simple methods of filtering honey as given at the beginning of this article, it is believed, will be within the reach of all beekeepers, large or small, both in point of first cost and the necessary skill to operate. No apparatus is needed beyond what can be made by any tinsmith. The product, if directions are carefully carried out, will be nearly as clear as that coming from the process described by the government chemists.

HONEY, FLAVORS OF.—Every beekeeper knows the delicious flavor of different honeys, and those familiar with honeys from various flowers are able with considerable accuracy to determine their origin. It is reported of one honey taster that he was put to the test to determine the accuracy of his judgment in the sources of honey and that he was able to distinguish and to estimate with fair accuracy the per cent of an addition of five per cent of pure sweet clover honey to a pure alfalfa honey, both of which have

flavors of rare delicacy. The discrimination of honey flavors of most beekeepers is far less acute than this, yet they all recognize the flavor as one of the most important characteristics of honeys.

The Delightful Odors of Honey

That the pleasing effect of honey is chiefly odor rather than taste is evident when one enters a bottling plant where honey is being warmed for bottling, for at such times the odor is sometimes almost overpowering. The materials, whatever they may be, are volatile and it is safe to assume that they affect the sense of smell rather than that of taste, although it is often difficult to distinguish between these two senses.

Many plants and flowers present delightful odors, sometimes at the same time offering to the bees a liberal supply of nectar but sometimes without secreting nectar. The odor of the flower or plant and the odor of nectar or honey are usually similar, but, since many odoriferous flowers are nectarless and many nectar-secreting plants are virtually odorless, it must be concluded that the odor of the flower may be quite distinct from that of the nectar. Buckwheat of an afternoon fills the air with the odor of its flowers, although the nectar has ceased to fill the blossoms at noon. The strong but delightful odor of new-mown hay is well known, but hay gives no nectar.

The floral origin of honey odor is quite clear, at least to the extent of its principal amounts. Those familiar with different honeys can distinguish the delightful flavor of clover honey from the more penetrating odor of basswood. The mint-like flavor of alfalfa honey and the vanilla-like flavor of sweet clover honey are easily recognizable.

In the work of E. K. Nelson, Division of Food Research, Bureau of Chemistry and Soils, entitled "The Flavor of Orange Honey," published in Industrial and Engineering Chemistry 22:448, May, 1930, Nelson says: "The pleasant, floral odor of orange honey suggests the presence of methyl anthranilate. . . ." Again, in a paper published in 1932, R. E. Lothrop, "Specific Test for Orange Honey," Industrial and Engineering Chemistry, Anal Ed. 4 (4):395-396, October 15, 1932, makes the statement a little stronger by saying: "As pointed out by Nelson, the distinctive pleasant aroma of orange honey is due to the presence of methyl anthranilate."

It is impossible to describe these flavors in any manner other than to suggest a similarity with some other flavor, for there are no words which enable us to describe these properly. While these odors are characteristic of the floral source, yet honey which has remained with the bees for a considerable time carries a richness of flavor not to be found in freshly gathered honeys. Those who have tasted completely ripened and aged honeys, left with the bees for a long time, must realize that some odor or taste has been acquired by the honey which it did not formerly have, and which did not come wholly from the flowers.

It is well known that a minute quantity of perfume may give rise to odors which permeate a large room without appreciable loss of weight of the perfume. In ordinary chemical analyses of honey, there is left an undetermined amount consisting of a variety of things, among which are the flavoring materials. Evidently the total amount of flavoring material is small, and it is also well known that by improper handling and especially by overheating in open vessels the flavor of honey may easily be lost, leaving behind merely a sweet syrup without character. (See Bottling Honey, Granulated Honey, and Honey, Heat Effect on.) It is thus seen that the total amount of this highly essential and most important constituent is scant in most honeys.

In all probability the flavoring material is not of the same nature in all honeys, although there are no adequate analyses which show what these materials are. Various statements, or perhaps more properly, guesses, have been made of which the following are examples. In Browne's excellent bulletin on American honeys he lists among the undetermined materials without a definite decision "aromatic bodies (terpenes, etc.)." Other authors have mentioned volatile oils as present, so far as known without chemical evidence to support such a theory. Others have believed that the flavoring materials are members of the higher and more complex alcohols. Probably a highly important constituent of the flavoring substances are volatile acids and acid compounds, of which several are known to occur in honeys. (See Honey, Acidity of.)

In order that any material may give rise to an odor, it must be volatile, that is, it must freely and quickly pass from

a liquid or solid state to that of a gas. Heat facilitates this transformation and also the escape of the odoriferous material into the air so that it may reach our nostrils and be perceived as an odor.

Precautions to Prevent Loss of Flavor

Considerable amounts of odoriferous material are lost during the ripening process in the hive, for on still evenings the odor of honey in the apiary during a honey flow is often quite marked. This much of the loss of odor is unavoidable and perhaps often desirable, at least for certain honeys. In the process of extracting a valuable amount of odoriferous material is often lost, as must be appreciated by any person who has been in a honey-house as the honey passes through the extractor. It is well known to experienced beekeepers that comb honey has a delicacy of flavor not possessed by extracted honey, for there is an inevitable loss even with the best of mechanical operations in extracting. It is, unfortunately, one thing to appreciate this loss and quite another to point out a remedy for it. If honey could be extracted at lower temperatures, a considerable amount of this loss might be avoided, but every beekeeper knows how difficult or impossible it is to extract honey that is not warm from the hive or later warmed to about the same temperature. When honey is uncapped and put into the extractor, it passes from the combs to the outer can in fine threads, thus greatly increasing the exposure of the honey to the air and permitting the odor to escape. While still fairly warm, it passes down the can and into the settling tank. A delightful odor arises from these tanks, showing that the loss of odor still goes on. By covering the extractor, as advised in some types of machines, and especially by keeping the settling and storage tanks sealed as tightly as practicable, some of the odor may be saved, but in spite of all that one can do in all ordinary methods of handling, there is an odor in the honey-house during extracting that proves to us that the most important material in honey is to some degree escaping.

All beekeepers know from personal experience how good it is to eat cappings as they are removed by the knife, and also how good extracted honey is just as it comes from the extractor. It rarely is so good again, more is the pity. But the most severe and avoidable losses come from subsequent handling, in the various stages of preparation for bottling. (See Bottling.) To bring honey to a temperature sufficient to insure complete liquefying of all dextrose granules in a vessel or container that is not sealed tightly means a loss of flavor which can not be measured but which is high. In the final heating of honey to a temperature for bottling, in order to insure a liquid condition for a considerable time, there is still a greater danger of loss of flavor and at this point honey is often ruined. To overcome these losses as far as practicable, many bottlers keep the honey while it is being heated in closed and even in hermetically sealed containers, and this is a practice to be commended for any time or place that honey is being heated. It is one thing to point out places of danger and still another to provide remedies, but about all that one can do to add to the merit of our honeys from the standpoint of flavor is to see to it that at no time when avoidable is the honey left exposed to the air, especially when it is warm.

Not all honey flavors are pleasant. Bitterweed in some southern states provides a honey that is inedible, and chinquapin honey is also undesirable. Mountain laurel honey (See Poisonous Honey), causes unpleasant physiological effects, and is so bitter that one could not eat much of it, and many honeydew honeys are far from pleasing. Freshly collected goldenrod honey sometimes has a most unpleasant odor, comparable only to something decaying. Fortunately the unpleasant honeys are rare, but we also have another group of honeys that are strong yet pleasing. Of the stronger honeys that find a ready sale, buckwheat may be mentioned, and it is possible to state from a personal experience that this honey grows on one. In contrast to the stronger honeys, there are those in which the odoriferous material is so scant and the odor is so delicate that only a connoisseur can appreciate them. Some eastern beekeepers refer to certain western honeys as tasteless, whereas those more familiar with these honeys recognize them as delicately and deliciously flavored.

Flavor Affected by Physical Conditions

The subject of honey flavors must not be passed over without comment on the changes in taste which occur in honeys under different physical conditions. The

explanation of these changes is still a mystery. All honeys seem to undergo a change in taste or flavor when granulated, and while all edible honeys are equally good in liquid or crystallized form, the tastes are not the same. Not only is this true, but when the so-called honey butters are made, either by causing a finer granulation or by the breaking of the normal dextrose crystals, the taste is still different from that of the usual granulated honey of the same floral source.

Warm and cold honeys do not taste alike. It is easily understood that warming might facilitate the escape of odoriferous materials and thus cause a change in the effect which a honey would have, yet somehow in some honeys there seems to be a change in quality of flavor rather than of quantity. If one may be permitted to express a personal preference, it is that a delicate honey chilled to refrigerator temperature just before serving surpasses anything in the way of honey that it is otherwise possible to find. Of course, honey should not be stored under such conditions, but it seems to bring out all the delicacy of the flavor simply to chill the honey before serving. And possibly, even probably, this is merely imagination.

Value of Pleasing Flavors in the Diet

The flavoring substances of honey are its most valued constituents. The American diet is all too often a drab thing, but we are coming more and more to appreciate the aesthetic side of our food. We properly pride ourselves that we do not live to eat but that we eat to live, but perhaps an over-emphasis of this attitude has sometimes deprived us of real and worthy pleasures. If one wished to live the life of sacrifice and to suffer in the flesh in all possible manners, presumably he might sustain life on a diet of corn syrup, tasteless and unflavored meats, spinach and other entirely wholesome but not tasty foods, but it would indeed be dreary fodder. We consider it worthy to admire excellent music or to seek joy in the beauties of nature. Why not find joy in eating good things within the proper bounds of dietary propriety? Other nations give more regard to the goodness and beauty of their foods than do most Americans, eating no more and often less than do we, but receiving from the taking of food a great enjoyment. We now more and more recognize that in eating there is a psychological side to be satisfied which is perhaps largely responsible for the recent advance of home economics, which not only considers the calories of food but also its beauty. We even now spend thousands upon thousands of dollars to bring spices from the orient to make our foods taste and smell better, and this is not money wasted if we can not obtain so fine an effect otherwise.

The flavors of honey place it in the class of foods with spices and other condiments. Honey has a food value in itself and enhances our enjoyment of other foods with which it is eaten, so that it serves a dual purpose. As a source of carbohydrate food it is important, but as a source of taste and odor it far surpasses its value as a source of calories. Honey is the only available sweet except the maple products, its worthy cousins, which are tasty and good of themselves. It then behooves the beekeeper and the ardent advocate of honey to emphasize the aesthetic value of honey, quite aside from its sugar content, so that they may assist their friends, neighbors and customers to receive a real and worthy satisfaction. If one presumed to place a monetary value on the priceless flavoring materials in honey, in view of the minute amounts there found, he would perhaps place the figure at over $1,000 a pound, perhaps far more than this if only we knew how small an amount is there present. There is no substitute for this goodness and honey is its unique source. We can add nothing to the goodness of honey as it comes to us from the bees, but we can subtract from this goodness, so it should be a constant care that nothing which we do to honey shall destroy or reduce this virtue.

HONEY, FOOD AND MEDICINAL VALUE OF.—The use of honey as a food for normal individuals and its use as medicine are so closely associated that it is difficult to draw any sharp line between them. Honey as a quickly assimilated food for normal adults carries over this same virtue when used for persons suffering from disease of various sorts. This very virtue of quick absorption and assimilation explains the use of honey for those persons whose digestive processes are retarded. If cane sugar, which needs time for digestion before absorption, remains too long in the alimentary tract be-

fore digestion is completed and absorption is possible, the sugar is sometimes attacked by micro-organisms and fermentation occurs. This is often accompanied by gas formation and its attendant distress, the old fashioned "heart burn," which has nothing to do with the heart. When honey is consumed in place of sugar by persons having this fault in their digestion, fermentation does not have time to take place before the sugars of honey are absorbed and enter the blood stream, and no distress occurs.

Honey a Source of Quick Energy

It is, of course, well known that the use of honey gives a quick energy release, so that athletes use it when exerting themselves strenuously in order that the lack of sugar in the blood stream resulting from muscular movement may be quickly rectified. (See Honey, Athletic Use of.) In similar manner and for the same reason, honey is preferred by many physicians as suitable for the diet of aged people or young children who likewise sometimes are in need of a quick energy source. See references further on.

For these purposes honey is to be preferred to other sugars and sweets in any cases of shortage of sugar in the blood and for a quick energy source. It has the merit that it is safe for all persons who are liable to utilize sugar, with the exception of those rare individuals who have an idiosyncracy against honey. (See Honey Cramps, page 397; also Honey Sensitization, page 486.)

The flavor of honey should not be overlooked in a consideration of its merit for abnormal persons. Frequently such persons need just that sort of appetite stimulation which the delicate flavors of honey provide. Too often beekeepers under-estimate the value of honey flavors, looking on this feature of their honey as of scant merit in consideration of honey as a food or medicine, whereas flavor alone may make honey far preferable for those with abnormal digestive processes. (See Honey, Flavors of.)

Honey is a highly concentrated solution, so that when ingested it quickly begins to absorb moisture from the walls of the alimentary tract. This often causes thirst, and for those persons who need larger amounts of water than they normally take, this may become an added benefit from the use of honey.

The laxative effect of honey has long been recognized, and this feature of the use of honey is often highly recommended, but it is not usually recognized why honey has this effect, although certain German workers attribute this effect to the enzymes of honey. It is probably due to the fact that when honey is eaten, its high osmotic action causes the absorption of moisture from the walls of the alimentary tract which continues until the honey is all absorbed. This absorption of moisture, combined with the tendency to alleviate the thirst thus created, account for the laxative effect. There is nothing in honey which acts as a drug to cause increased parastalsis of the alimentary tract. In those cases where any drug action to relieve constipation may be dangerous, the use of honey can be advised, as it carries no injurious effect whatever.

Great Value in Children's Diseases

Honey has been used by various specialists for children's diseases, sometimes with results which seem unbelievable. They report not only increased weight in abnormally thin children, which one might expect from a diet rich in honey, but also a gain in the pigmentation of the blood through the formation of blood corpuscles. It is claimed that checks with the use of malt sugar instead of honey failed to give this result. The scant amount of iron in honey can scarcely be the full reason for the blood change, and it may be that the derivatives of chlorophyll, which all honeys contain, are in part responsible, since this material, often absorbed only with difficulty, may be increased in effectiveness because of the particular form in which they occur in honey. Apparently not many specialists in the care of children or those engaged in building up emaciated children have recognized this merit of honey, although enough instances have been reported to justify one in asking why this effect has been possible. Some of these reported benefits have come from high altitudes and the use of honey has been accompanied by complete rest, yet there seem to have been enough checks to warrant the conclusion that the honey of itself had some influence in the rapid building up of the unfortunate children under treatment. (See Honey in Infant Feeding, pages 462, 471, and also pages 464 and 465, Honey Builder of the Blood.)

Soothing Effect of Honey

Honey is also commonly used as a cough medicine, usually as a home remedy. Those who have studied city markets for honey have all been struck with the large amounts of honey bought for use as cough medicine rather than as a food. In some parts of the foreign population, this seems to be a chief reason for buying honey. For this purpose it has virtues, since honey is soothing. It covers the irritated surface and the absorption of moisture from the membranes lining the throat doubtless serve to relieve the congestion of the tissues affected. Honey diluted with water is also used as a gargle.

Apparently for exactly the same reasons honey is used as a salve or in poultices, either alone or with some disinfecting or healing drugs, for boils and other skin affections. In these cases also, the chief merit, aside from some ability of honey to destroy germs, probably lies in the absorption of moisture to the surface, keeping the skin moist and soft at the point of attack and the retarding of evaporation from the skin.

Honey is also often used as a vehicle for drugs instead of a sugar solution. For this purpose it not only affords a pleasant taste but, like the sugar solution, its specific gravity is higher than that of water and microscopically minute particles of drugs are kept in suspension instead of settling too rapidly to the bottom. In a similar way it is used to cover the taste of ill-tasting materials and decoctions which children do not like. In these instances taste is perhaps the most important factor of the honey.

One of the good old-fashioned ways of breaking up a cold is to drink large quantities of water, made more palatable in some way or other. Hot lemonade is a popular home remedy of this sort, and it is doubtless the hot water rather than the lemon which is helpful. Those who have tasted hot lemonade sweetened with honey know how vastly superior it is to ordinary hot lemonade, and the use of honey has the additional merit of providing a quick energy supply which is often needed in colds. Honey and hot water alone is not bad to take. In any case where heavy secretion of perspiration or urine is desirable, a similar sort of "medicine" should be effective.

Use for Diabetic Patients

The most serious disease in America in which impaired sugar metabolism is encountered is diabetes. In this disease, the patient lacks that mysterious material from the pancreas which enables the muscles and other body tissues to utilize sugar, with the result that the elimination of sugar through the kidneys is abnormally increased and sugar in the urine results. No end of ill effects arise from the cause of this trouble, of which the sugar in the urine is an effect. The discovery of insulin, the lacking secretion of the pancreas for use in these cases, has brought not only longer life but also greatly increased happiness to thousands of afflicted persons.

There is one story regarding the use of honey in a case of diabetes which may be told, since it suggests that honey has some merit which we can not identify or explain at present. A beekeeper who suddenly discovered that he was suffering from diabetes went to a specialist, his tolerance for sugar was carefully determined and he was instructed thoroughly as to his diet and the use of insulin, which he was to administer himself daily. In the use of insulin, one of the dangers lies in the fact that if one takes too much insulin or takes the regular dose when the insulin is not shortly followed by a meal, the result may be disastrous, sometimes resulting in coma as fatal as that from an oversupply of sugar in the blood. An undersupply of blood sugar may be as fatal as an oversupply. This beekeeper was carefully instructed as to what to do in the event of an overdose, and was qualified to take the necessary steps which were immediately to eat sugar, or in case of dire emergency to inject sugar into the blood stream.

But, being a beekeeper, he preferred honey to sugar, so when the first case arose in which he needed sugar to overcome the effect of too much insulin, he took a liberal allowance of extracted honey. To his surprise, the effect of the insulin did not disappear, as it should have done if sugar had been taken, and he was compelled shortly to take some sugar. This failure of honey to alleviate the effects of too much insulin at least suggests that there is something about the use of honey as food for diabetics which differs in its effects from the use of sugar.

Proof of the Foregoing Statements from High Authority Both in America and Europe

It perhaps would seem unnecessary to add corroborative evidence in support of

the statements just made, showing the value of honey as a food and medicine, but there are some people and some physicians that must be shown before they can be convinced. All such are referred to the article on Honey in Infant Feeding on page 471. While those statements relate to small children, they will apply to old people and all others having impaired digestion. Even the strong and healthy may be interested in keeping themselves fit by learning what sugars are better than others, especially why nature's concentrated sweet, honey, occupies a unique position among all sugars.

In one of its press releases entitled, "Honey High in Food Value," the United States Department of Agriculture stated:

Honey is one of the best of the high energy-producing foods. Because it is composed almost entirely of simple sugars, it can be assimilated with ease. Most sugars require action by the gastric and intestinal secretions to break them down into simple sugars similar to those occurring naturally in honey. Because it is easily assimilated, honey is of importance where normal digestive activities have been impaired by disease or old age. Honey can be utilized by the body without placing much of a burden on an enfeebled digestive tract and is also recognized as a valuable food for babies and young children.

"The Science of Health and Disease," by Howard W. Haggard, Associate Professor of Physiology at Yale University, recognizes this value of natural sugars and points out, "The taking of readily assimilable carbohydrates is stimulating and helps to relieve fatigue." Honey is one of the most assimilable carbohydrates.

A Noted Food Expert's Opinion

Professor Phillip B. Hawk, of Jefferson Medical College, Philadelphia, Pennsylvania, a noted food expert and a specialist in vitamins, carried out a series of experiments upon a normal man to determine the influence of honey on gastric digestion. He first fed the man 40 grams of whole wheat bread alone. The contents of the stomach were analyzed for acid and pepsin at 15-minute intervals and an accurate and detailed record was kept. The experiment was then repeated, adding to the bread half its weight in honey, 20 grams. Following are the results as told by Dr. Hawk:

An examination of the chart will show that the bread with honey was digested, and left the stomach as quickly as the bread alone. Similar pepsin values were obtained; and while there was a slight depression of acidity such as always follows the ingestion of foods containing much sugar, digestion was completed as soon as with the bread alone, although the addition of honey had practically doubled the food value of the product from the energy standpoint.

The use of honey with bread and in similar ways would, therefore, appear to be generally preferable in the case of children to the eating of candies. Honey serves to make the highly nutritious bread far more palatable, leading to the consumption of body-building foods instead of depressing the appetite, as is likely to be the case with candies which are eaten between meals. At the same time honey furnishes the body very considerable amounts of energy in the most available form. The high place given to it in the diet is, therefore, well deserved.

Opinions from Medical Sources

One of the leaflets of the American Honey Institute which bears the seal of approval of the Committee on Foods of the American Medical Association, contains the following paragraph:

Most sugars must be broken down into simple sugars by digestion before they can be assimilated. The simple sugars resulting are identical with those found occurring naturally in honey. For this reason honey requires practically no digestion. It is almost wholly available for immediate absorption into the body. This is one reason why it is recognized as a valuable food for babies and growing children.

What do modern physicians say on this subject? Dr. R. G. Flood (Archives of Pedriatrics, 42:1925, 50) reporting his observations in a western hospital on the subject of the selection of sugars in infant feeding, says:

Honey owes its ease of absorption to the free available dextrose in the mixture, and its laxative action to the levulose fraction, which is absorbed slowly, so it eventually reaches the large intestine. These properties make honey a very valuable sugar in the treatment of constipated bottle fed infants, and in our hands have profited these children a great deal.

In discussing the therapeutic effects of various food articles, Dr. A. M. Liebstein (American Medicine, 33: 1927, 33) from the other side of the continent, writes:

Honey is a very concentrated and nutritious food article, and easily digested and assimilated. It is a good emollient, soothing, vitalizing, an energizing agent. It has a good many therapeutic indications. It is very beneficial in diseases of the pharynx, larynx, kidneys and bladder. It is laxative and sedative in its therapeutic actions.

In the Lancet, the world's leading medical journal (1924) 207 (5287); 1363 appears an article "Honey: Its Value in Heart Failure," by G. N. W. Thomas, M. D. Ch. D., of Edinburgh, Scotland. As Dr. Thomas is one of the eminent men of his profession in Great Britain, what he has to say will have weight. The article with the editor's comment, is here reproduced:

HONEY: ITS VALUE IN HEART FAILURE

G. N. W. Thomas, M.B., Ch.B., Edin., Scot.

It has been said that the main role of carbohydrates in metabolism is to provide fuel for muscular energy. I desire to call attention to the great value, which I believe it to have, of honey as a restorative in health and sickness.

When muscular energy is required, and particularly after emotion stimulation of the sympathetic nervous system, there is found to be an increase of sugar in the blood. The

various sugars found in the body may be classified among the mono or the poly-saccharides; glycogen belongs to the latter group, and is apparently a storage product in muscles as well as in the liver. The energizing effect of sugar on muscular effort has been proved by Schumberg's experiments with the Ergograph. Muscle in action, it has been computed, can consume three and a half times as much sugar as muscle at rest. Starling found that the normal heart used up sugar at the rate of about 4 milligrams per gram of heart per hour. Nectar, which bees collect from various flowers, contains a special sugar which undergoes some change to honey.

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In severe cases of malnutrition with heart weakness, I have found honey to have had a marked effect in reviving the heart action, and keeping the patient alive, and I had further evidence of this in a recent case of pneumonia.

The patient consumed two pounds of honey during the illness; there was an early crisis with no subsequent rise of temperature, and an exceptionally good pulse. Instead of depending on milk and beef extracts, as is done in so many cases of fever when the storage of sugar in the body is rapidly being used up, I suggest that honey should be given for general physical repair and, above all, for heart failure, and for reasons similar to those set out above, grapes constitute a valuable adjunct. Herbivorous animals thrive on clover, no doubt because of the nectar which is probably vitaminous in the white and red clover flowers "My son, eat thou of honey, because it is good" (Prov. XXIV. 13.)—London Lancet

Editor's Note —It is stated that honey contains both the fat soluble and water soluble vitamins. Various enzymes, such as invertase, are present The nectar containing fairly high properties of sucharse, is digested in the crop of the bee by means of invertases, secreted by glands in the head and thoracic regions. Conversion, however, is incomplete in the bee itself, as it continues after the honey has been deposited in the hive.

On these findings, honey constitutes a valuable food since it contains carbohydrates in a form suitable for direct absorption. The claim is made that honey seldom gives rise to fermentation in the alimentary canal, since the dextrose and levulose, being monosaccharides, are absorbed so rapidly that there is little time for bacterial action. This would commend it for infants and children, especially to ward off deficiency diseases. The fatty acid content is of more or less value in stimulating peristalsis and digestion It seems, therefore, that Dr. Thomas's plea for the considerate and extended use of honey has sound biochemical basis.

A Life Insurance Medical Director Strongly Endorses Honey

Commenting on this article of Dr. Thomas, Dr. C. H. English, the medical director of the Lincoln National Life Insurance Company, of Fort Wayne, Indiana, wrote an article which was published in Gleanings in Bee Culture for March, 1927.

As this is corroborative of what Dr. Thomas has already said, this is likewise given as follows:

HONEY, THE HEALTH SWEET

By Dr. C. H. English

Medical Director, Lincoln National Life Insurance Company

The second paragraph of Dr. Thomas' article published in the Pharmacal Advance is especially interesting where he refers to the proven energizing effect of sugar or honey upon muscular fiber. He says: "Starling found that the normal heart used up sugar at the rate of about four milligrams per gram of heart per hour." This statement to me is the crux of the whole matter.

Value of Honey for Weakness of Heart

In any prolonged disease, such as typhoid fever, pneumonia, and more especially pluro-pneumonia, where the intestinal digestive function is very greatly impaired and where the liver function is badly crippled, and in some cases practically out of commission as evidenced by the jaundice in many of these cases, it becomes necessary to supply the heart muscle with this necessary food (I prefer to call it a food rather than a stimulant) that does not require any chemical change either in the bowel or in the liver as it passes through the hepatic system on its way to the general circulation, there to be used in the upkeep of whatever part of the body needs it most.

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In diseases of the respiratory tract honey was not given for its value as an expectorant. but for its apparent value upon the heart muscles. When patients neared or were in the crisis a very marked effect was noted if honey was given rather freely. I found it also noteworthy that these patients would tolerate large quantities—several ounces of extracted honey per day. The benefit was so apparent that it became a routine practice in conjunction with other treatment. No other food or heart stimulant had such a lasting effect upon the myocardium.

This practice was carried on over a period of fifteen years with the most gratifying results My records will show that in several cases where we were unable to procure honey in the early stages (often my own supply was exhausted, so that there was sometimes a delay of several days before we could secure suitable honey), if the patient was not moribund the change or effect of the honey was quite marked. I could advance no other theory than that the honey had a direct effect upon the myocardium.

Honey for Typhoid Fever Patients

What is true of honey in respiratory diseases is also true in typhoid fever, only in a little different way. We do not have typhoid fever as formerly, since we now vaccinate against it, just as we do against smallpox. But we have a few sporadic cases yet, so it may not be out of place to say a few words about it also.

The disease is located in Peyer's glands, which are located in the ileum, or lower half of the small intestine. These glands become diseased, greatly impairing the normal function of the bowel. The peristaltic action, or the action of the bowel that carries the food along through the bowel, is very much impaired because of the weakening and impaired condition of the muscular fiber of the bowel. In this disease great difficulty is experienced with the fermentation of foods, thus causing an accumulation of gas. Cane sugar is used almost exclusively to sweeten the fruit juices that are given during this time, which in many cases causes a very embarrasing condition, as it has to undergo chemical change before it can be assimilated. So why not use honey, which not only makes the drink palatable, but rarely ferments, and, most important of all, supplies strength and tone to the bowel and also to the system generally? This is done at no expense or effort on the part of the general system other than to take the honey directly into the blood stream, from which it may be deposited where most needed.

Honey can also be used very extensively in the preparation of foods for infants and for early childhood for the reason that it does not have to undergo any chemical change and rarely causes fermentation or other intestinal disturbance.

A Famous European Doctor Strongly Favors Honey

Another eminent medical authority, a prominent lecturer and author of several medical books, is Dr. Arnold Lorand, of Carlsbad, Czechoslovakia. In several of his books, especially in "Old Age Deferred" and "Life Shortening Habits and Rejuvenation," published by the F. A. Davis Co., Philadelphia, he mentions honey particularly for people of weak digestion and especially for those who have a weak heart. His books are full of references to honey. Among other things he recommends a teaspoonful or tablespoonful of honey in hot water, stirring well and then drinking, if one is greatly exhausted by over-exertion. Even healthy and strong people, over-tired, will find this a panacea, as the author knows from experience. Dr. Lorand's books are written in a simple, clear style and are as interesting as a romance.. It would not be possible to quote him all the way through, but a few quotations are here given from his books that will show what he thinks of honey. In "Old Age Deferred" he says: "As a most valuable food for overwork of the heart and the general circulation, I recommend honey." Then in a further chapter he says:

The Best Food for the Heart

A weak heart is most frequent in severe diabetes, as in such a condition the sugar ingested can not be utilized and entirely eliminated in the urine. For this reason I consider it unwise to place severe cases of diabetes on a strict diet and I recommend to them the use of fruit sugar (levulose), which is often well utilised and especially in a case of diabetes with heart failure I like to do this. Such persons should never be strongly dieted. As the best food for the heart I recommend honey on the base of the above-mentioned observations. Honey is easily digested and assimilated; it is the best sweet food, as it does not cause flatulence and can even prevent it, to a certain extent promoting the activity of the bowels. It can easily be added to the five meals a day I recommend in cases of arteriosclerosis and weak heart. As it would be unwise to leave such a hard-working organ as the heart without any food over the long hours of the night, I recommend heart patients to take before going to bed a glass of water with honey and lemon-juice in it and also to take it when awaking at night (honey dissolves in warm water).

Before and after muscular exertion honey should be given in a generous dose; no coachman would allow his horses to run for hours without giving them food at the resting intervals. Only man is so unreasonable as to undertake heavy exertion often with an empty stomach. No wonder that so many sportsmen get a weak heart simply for just such a reason. The use of sugar can not well replace honey.

Honey a Hygenic Food

Then in his book, "Life Shortening Habits," above referred to, he says this:

It has been shown that after the performance of work the muscles contain less glycogen. In the last edition of my book, "Old Age Deferred," I showed that sugar, and, above all, honey, is an excellent remedy for a weak heart precisely on account of the above mentioned principles, the nectar of the flowers, which is the source of the honey, having stored up the energy of the sun's rays. We know that all starchy food and all sugarlike matter in nature can be created only through the help of the rays of the sun—that greatest benefactor of the human race as well as of the animal and vegetable kingdoms.

Again, the same authority in another book, "Health Through Rational Diet," says:

We consider honey as a very excellent and hygenic food. It is gathered as nectar from the flowers by the bees, and is by them digested, thus converting the sugar into invert-sugar—a mixture of grape and fruit sugar. The bees then deposit the honey in the combs in the hives.

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Honey may render us very valuable services. It should never be missing in a vegetarian diet, but in any sort of a diet good honey taken at breakfast will be very beneficial, as it has a very favorable effect upon the action of the bowels.

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In Pharyngeal and bronchial catarrh it has a very soothing effect. In some countries it is used as an external application for painful areas. In solution it may be added to certain medicaments and beverages thus increasing their action.

Honey a Builder of the Blood

Some work done in Switzerland shows the haemoglobin regenerative power of honey. (Haemoglobin is the coloring material of red corpuscles of the blood.)

Dr. Paula Emrich in the Bienen Zeitung, page 136, for 1923, as a physician reports that the "honey cure" at R. A. Franenfleders children's home was never without success in the case of about 200 children. The haemoglobin content and usually weight, as well as other physical characteristics improved.

Honey was not found to cause hyperacidity of the stomach if given properly, say, a maximum amount of one tablespoonful twice a day dissolved in milk.

Again, Dr. Paula Emrich in the "Bienen Zeitung" for 1932, page 616, published results on parallel experiments with and without honey.

At the start of the cure the patients received twice daily one teaspoon of honey dissolved in a cup of warm milk; later on, the quantity of honey was increased to two tablespoons a day. This increase was performed gradually and, with a few exceptions, did not produce any digestive disturbances.

Since there were many other beneficial factors involved in the treatment, such as mountain air, excellent nutrition and continuous care, it was necessary to perform experiments which would doubtless show how much of the results could be attributed to honey. For this experiment Frau Dr. Emrich selected six groups of children with as closely as possible related characters. Preferably, children were chosen which showed a close relation in regard to age, size, constitution, haemoglobin content of blood, likeness in type, and they came either from the same family or from families with similar living conditions. In each group there were two children of which one received honey and milk and the other milk alone. Group one were twins, the others mostly brothers or sisters. The comparative results in relation to the increase of haemoglobin value are presented in the following statistics:

	Per cent haemoglobin at start.	in 2 weeks.	in 6 weeks.
1. Erica	58	62	72 without honey
Sentt	56	69	75 with honey
2. Elli K.	62	63	70 without honey
Hans K.	62	67	74 with honey
3. Erica K.	55	58	59 without honey
Anneliese K.	55	58	64 with honey
4. Irma S.	57	58	61 without honey
Lisbeth B.	58	62	75 with honey
5 Marta D.	52	58	63 without honey
Gertrud D.	50	58	74 with honey
6. Marie D.	48	55	63 without honey
Grete D.	50	58	72 with honey

Of interest is the additional observation that the children which did not receive any honey, but otherwise the same diet, increased more in weight, while the honey-receivers gained less weight, but considerably more in haemoglobin content of the blood. The statistics show that after six weeks of treatment with honey every child reached, or nearly reached, the normal haemoglobin value. To avoid sources of errors in this work Frau Dr. Emrich has tried to be as purely objective as possible.

If there are 70 per cent sugars found in honey, two tablespoons of honey would represent about 20 grams of sugar or 80 calories and the beginning dose, a teaspoon of honey—about 26 calories. The addition of such a small amount of calories could not alone be responsible for this success. It seems more probable that honey has a roborative and activating influence upon the body cells and has to be classified as a protoplasma activator.

The following three references confirming those already given should satisfy any person or doctor that honey has merits in making strong, healthy children.

Frauenfelder, R. A. 1921. Neuere wertvolle Erfolge mit Honigkuren. Schweizerische Bienen-Zeitung 44: 321-323; 351-355; 391-394. Children in a children's home in Switzerland were divided into three groups. Group 1 was given an ordinary diet without any honey; group 2 was given an ordinary diet plus honey as prescribed; and group 3 was given an ordinary diet plus various tonics but no honey. The aenemic children in group 2 after a few weeks surpassed the other groups in increase of haemoglobin and weight, as well as in quickness and completeness of cure from asthma, bronchitis, nervousness, and certain other ailments. Fraunfelder holds the effect of honey is indirect in that it stimulates the general building up of the body and this in turn is responsible for the various cures. He lays stress on the fact that the honey is given dissolved in warm, but not boiling milk. Unthinned honey, as for instance when spread on bread, was at times found to remain undigested. When unthinned honey was given to weakly children, undesirable after- effects were often found but thinned honey could be taken readily by such children. The children undergoing the honey treatment were given up to two tablespoonfuls a day, depending on the age and condition of the child. For children over 10 years of age less care as to amount of honey was needed. Honey also acts as a laxative. Whoever has a stomach with too sensitive nerves, or a hyper-acid stomach, should avoid undiluted honey, especially granulated honey.

Muniagurria, Camilo. 1931. Le miel del aebilles dans la dietique normale et therapeutique du nourrison. Bulletin de la Societe de Pediatrie de Paris. 29:227-245. Reports honey beneficial in child feeding. This holds for certain intestinal disorders. Discusses why honey is of value in child feeding. Ascribes its laxative effect to its neutralization of the alkalinity of the intestinal tract instead of to any stimulation of peristalsis or of intestinal secretions. Has antiputrid properties in that it tends to influence the growth of saccharolytic flora so that favorable conditions for digestion result which are comparable to those found in the case of breastfed babies.

Rolleder, Anton. 1934. Untersuchungen uber den Wert des Honigs fur die Ernahrung von Kindern. Bienen-Vater 66:281-283. Made a controlled feeding experiment during the school year with 29 pairs of boys in an Austrian orphanage, each member of any pair being as alike physically as circumstances permitted. For six weeks one member of each pair was given one tablespoonful of honey every forenoon and afternoon, while the other boys were not given any. At the end of the experiment the honeyfed children as a group showed a gain in haemoglobin content whereas the others showed an average loss. In general, all the children gained weight, but this gain was larger in the case of the honey-fed children.

See other references favoring honey for children under head of Honey, Infant Feeding of, on page 471.

The function of haemoglobin in the blood is thus described by Prof. H. A. Schuette, Department of Chemistry, University of Wisconsin, and likewise the referee on honey of the Official Agricultural Chemists:

Honey is a natural, unrefined syrup from which nothing having nutritive values (I have particularly in mind its mineral matter) has been removed. Its major constituents are the sugars dextrose and levulose, both of which are directly absorbed by the blood stream without any previous tax upon the digestive system in so far as bringing about any necessary chemical changes to the end that they meet the body's requirements.

Among the mineral matter will be found practically all those chemical elements which are part of the human skeleton. Future research may perhaps contradict a sweeping statement as this, yet at the present writing and speaking in the light of the current knowledge on the subject, it is probably correct. Particularly would I like to call attention to the presence of those newer essentials copper, iron and manganese, of which there seems to be a larger quantity in dark honeys than in light ones. Iron is important from a nutritional standpoint because of its relation to the coloring matter of the blood, or haemoglobin. This haemoglobin, (we build it out of our food), has a certain power of carrying that all-important oxygen to the tissues of our bodies. If it were not for its iron content, haemoglobin would not have this property of holding oxygen. Copper seems to unlock the therapeutic powers of iron in restoring the haemoglobin content of the blood of patients afflicted with anemia. In other words, copper promotes the action of iron. We do not yet fully know the advantages of including manganese in the diet, but we do now know enough about the subject to appreciate that it is a valuable adjunct to the diet. Some are of the opinion that it functions more or less interchangeably with copper, or as a supplement to it, in aiding the formation of haemoglobin in the blood. On the other hand, others hold that copper alone helps iron in this business of building haemoglobin, yet they find evidence in other connections to support their opinions that manganese has a very specific function of its own in human nutrition. (See Honey, Sweetness of.)

Honey as a Mild Laxative

A number of the references under Honey in Infant Feeding, page 472, call attention to the fact that honey is a mild laxa-

tive especially for children. The following will give further proof if that is still needed. Dr. Paul Luttinger of New York and quoted in Honey in Infant Feeding, says:

Honey as Remedy for Constipation

We frequently find people who claim that they tried to use honey at some time in their youth, which was followed by a severe form of intestinal colic, and they remark that they have never been brave enough to try to use it again. In all probability, a larger quantity was taken into the system than was necessary at that time, which occasioned a very stimulated peristaltic action of the bowel, as honey does not act upon the mucous of the bowel as an irritant, consequently it must act upon the muscular fiber. This led to the suggestion in my mind that honey judiciously used, might be a very valuable adjunct in the treatment of constipation. Especially is this the case where there is apparently an enfeebled condition of the muscular tone of the bowel. Honey has proven to be a very valuable adjunct in my experience. As is well known in medicine, no remedy will work wonders in the large majority of cases in a short time, but any form of treatment requires persistence and a rather long time for the most favorable results.

These people who have had unpleasant results at some time from taking a rather large quantity of honey will find that if they will begin by using a small quantity, and gradually increase this amount, they will eventually be able to take a reasonable amount of honey without any unfavorable effects. It is barely possible that in a very few cases there may be an idiosyncracy against the use of honey; but these cases are extremely rare—so rare, indeed, that we can take the above suggestion for the use of honey as applicable practically universally.

It is further known that constipation, in combination with other factors, causes high blood pressure, and much may be done in cases of this character by the use of honey, in combination with other proper foods, to bring about a normal blood pressure.

Foods in Health and Disease, L. G. Graves (Macmillan, New York, 1932), on page 301, of the chapter on Gastro-Intestinal Diastase, states that the naturally laxative sugars found in pure honey "ferment and generate a gas that tends to break up the hard masses of feces," and so aid in correcting constipation and restoring and maintaining normal functioning of the intestinal tract. Other authorities concur in this statement.

Intestinal Toxemia, Biologically Considered (Davis, Philadelphia, 1930), Anthony Bassler, M. D. F. A. C. P., states that honey should be used "in place of cane or table sugar, which is constipative."

Caillas, Alin. 1920. Recherche de l'invertine dans le miel d'abeilles. Comptes rendus hebdomadaires des seances de l'academie de sciences (Paris) 170; 589-592. Holds invertase in honey aids digestion; it has a laxative effect.

Dr. B. F. Beck of New York City, referred to under the head of Honey in Infant Feeding, and under head of Stings, says:

As a laxative honey is par excellence. A teaspoonful as sweetening in a cup of hot coffee or tea instead of sugar is the best natural daily laxative. A tablespoonful of honey in a glass of barley water will serve the same purpose. * * * Ticknor Edwards wrote thus about honey: "Honey is good for old and young. If mothers were wise, they would never give their children any other sweet food. Pure ripe honey is sugar with the most difficult and the most important part of digestion already accomplished by bees. Moreover, it is a safe and very gentle laxative."

The Dangers from Effects of Too Much Refined Sugar for the Sick and the Well

Dr. P. Mabel Nelson, Ph.D., Department of Foods and Nutrition, Iowa State College, in the American Bee Journal, in one of the most comprehensive articles ever written on honey, page 446, for 1930, thus quoted Dr. Banting:

Doctor Banting the discoverer of insulin, has called attention to the incidence of diabetes in peoples who consume cane sugar in large quantity. In a lecture, given recently in England, he stated that among the natives of Dominica, in the Panama Canal Zone, where sugar cane is one of the main articles of diet, diabetes is practically never found. The sugar cane is eaten by the natives in the raw or unrefined state. However, among the wealthy Spaniards of Dominica, who consume large quantities of the refined cane sugar instead of the raw sugar cane, the incidence of diabetes is surprisingly high.

Doctor Banting says further that the effect of the ingestion of refined cane sugar is even more startling in India, where there is no diabetes among the poor classes, and where 40 per cent of the wealthy class over fifty years of age are diabetic. The following statements of his apply to our own country and not to foreigners: "In the United States the incidence of diabetes has increased proportionately with the consumption per capita of cane sugar. One can not help but conclude that in the heating and recrystallization of the natural sugar cane something is altered which leaves the refined product a dangerous foodstuff. (Banting, F. G. Edinburgh Med. J., 36: 18, January, 1929.) If such is the case, it is our responsibility, is it not, to attempt to remove the casual factor, either by improving the present product or by disseminating information about the danger of its use in over-large quantity and by encouraging the use of the natural or unrefined sugars.

It is not difficult to use the natural sugars. They may be used in cooked products as well as for a sweetening agent. The favorite of the natural sugars is undoubtedly honey. Honey has been used from earliest times, but probably has never been more appreciated for its true worth than it is today. Also, there is an abundance of information available on how to use it.

Elsewhere in the same article Dr. Nelson refers to the dangers of common sugar to children:

A study was made in the schools of New York City, in 1926, to determine the cause of the colds prevalent in school children. After eliminating such factors as ventilation, temperature of the room, type and amount of clothing worn, because they had no evident connection with the prevalence of colds, it was found that the incidence of colds correlated with the number of children consuming carbohydrate foods most extensively. In this same connection it has frequently been observed that European children in the tropics, when fed by native nurses, develop mucus diseases and adenoids. Supporting the finding that colds occur more frequently in children who consume carbohydrate foods extensively, is the experience of Dr. Amy Daniels, who has been able to protect little children from colds, sinus, and mastoid infections, by giving codliver oil and butterfat liberally in their diets.

The excessive use of sugar, particularly by children, is thought by Doctor Harris, a physician in one of our southern states, to be the most serious dietetic error of the present day.

According to Doctor Harris (Harris, S. New Orleans M. and S. J. 81: 159-166, September, 1928), "the sugar-fed child often becomes rachitic, is prone to colitis and other infections. If he survives infancy he becomes the pale, weak under-nourished child, or the fat, flabby, indolent and self-indulgent adolescent. Sugar-saturated vitamin-starving America presents a problem which may be approached through a study of the sugar-fed child with the idea that an ounce of prevention in the infant is worth more than a pound of cure in the adult." Equally startling is his statement regarding the adult's consumption of sugar—i. e., "Patients with ulcer of the stomach or duodenum, chronic gastritis, gall bladder infections and other abdominal diseases give a history of excessive indulgence in sweets too often for it to be mere coincidence."

Dr. E. V. McCollum, Professor of Chemical Hygiene, School of Hygiene and Public Health at Johns Hopkins University, Baltimore, addressing the Northern Ohio Dental Association's seventieth anniversary convention at Cleveland, Ohio, said that the American people ought to be ashamed at permitting two atrocities to be put over on them. He referred to highly refined foods in general, and to white flour and white sugar in particular. He said that of the two evils, he sometimes wondered which is the greater. When he thought of the thousands of children overworking in the beet sugar fields, working until they fainted from exhaustion, he decided that white sugar is a greater menace to American civilization than white flour.

Dr. McCollum called attention to the fact that the American soldier had no sugar in his rations until the year 1818. Recently the white sugar proportion in the American soldier's rations is very large. It now exceeds the national per capita consumption of 112 pounds.

Major Gessner has made a study of the evolution of the army ration, which will appear in the Military Surgeon in an early number. Major Gessner, after studying the physical appearance of soldiers that have served thirty-five years, calls attention to the fact that on account of their diet being too rich in manufactured and refined foods, they look older than men in other classes.

Dr. McCollum thinks that the beet sugar industry should never have been started in this country. He says there never has been a time that the tropics could not produce all the cane sugar needed—that the beet sugar has only had the effect of lowering the price and increasing the national per capita consumption. Beet sugar raising has never been a profitable industry for the farmer, although very profitable to the refiner.

We are now reaping the results of a diet composed too largely of refined cereals and refined sugars. We would be far better off if we would use more milk and more leafy type of vegetables, at the same time reducing the white sugar and the white flour.

Dr. B. F. Beck, author of "Bee Venom," and referred to under Stings in this work, also author of "History and Its Use of Honey," says:

That sugar is an important contributory factor in producing diabetes was best proved during the World War when it was not as prevalent in the United States. This can only be rationally interpreted as due to the lessened consumption of sugar during this period of time, long enough to justify the correctness of the statistical data. The subsidence of diabetes in the belligerent foreign countries was even more manifest.

Again Dr. Beck says:

Today honey is culpably disregarded and has fallen from its position of venerable and sublime esteem. It is a regrettable and lamentable error on the part of the present age and a sad reflection of its intelligence to neglect and almost discard the use of this most valuable food supply. It is almost unbelievable and difficult to explain why such a concentrated, delectable and ideal food, with its delightful bouquet, is missing from our tables.

Pollen, from which honey is made, is the procreative germ, the endocrine of plant life, which is transmitted to the human body when honey is consumed. Honey is physiological sugar and not a counterfeit. Through the prodigious genius of Nature, through a wonderful cycle, the energy of the sun is preserved in the nectar and pollen of flowers, and is liberated when honey is eaten. It is high time to reinstate it to its former exalted and glorified place. Honey is reasonable in price, is more nutritious than many other foods, for instance, butter, and keeps indefinitely.

Honey is a very important source of heat and energy. While proteins generate and replace tissues, carbohydrates create energy. It is no wonder that children have such a craving for sweets. It is only natural and fully justified. They expend so much energy that there is great need to replace its loss. In the Orient, and recently in California, lots of confectionary is made with apples, oranges, walnuts, raisins, and honey.

Clarence W. Leib, M. A., M. D., formerly associated with Peter Brent Hospital, Boston, now with Post Graduate Medical School and Hospital, New York City, member of the American Medical Association, New York State Medical Society, American College of Physicians and Harvard Medical Schools, in his book, "Eat, Drink, and be Healthy," pages 128-129, speaks about sugars in general as follows:

Sugar is undermining the nation's health By this I mean cane sugar, beet sugar, and to a much less degree, maple sugar.

The best sugars chemically are the simple sugars. These are liberally supplied by nature in fruit, honey and vegetables. They should be taken in their natural state and they require very little digestive effort for tissue utilization.

Cane sugar (saccharose)—this applies also to beet and maple sugar—is a complex and concentrated sugar physiologically. It requires too much digestive energy to convert it to simpler

form for absorption. It irritates the stomach. It retards digestion. It produces acid fermentation and highly acid gastric juice. It exhausts pancreatic activity and thus leads to diabetes.

Cane sugar which reaches the colon may stimulate the growth of toxin-forming bacteria. One of the products formed in this way in large amount is oxalic acid, which on being absorbed takes calcium (lime) out of the tissues and thus may cause kidney stones or reduce bodily resistance to infections.

According to Stefanson, the Eskimos had neither constipation, stomach or dental troubles while on an exclusive meat diet but since their use of devitalized sugars and starches, these diseases are the rule.

The sugars to which the alimentary canal are adapted to in large amounts are lactose, maltose, dextrose and levulose.

Dr. J. H. Kellogg, the head of the great Battle Creek Sanitarium, in his book, "The New Dietetics," of nearly 100 pages, published by the Modern Medicine Publishing Company, Battle Creek, Mich., says:

Bergeim, Rehfuss, and their associates found that both cane sugar and glucose, when freely used, diminished the secretion of gastric juice and delayed the emptying of the stomach. It is evident that cane sugar must be avoided in all forms of gastric diseases and especially in gastric catarrh, gastric and duodenal ulcer, hyperacidity, and gall bladder diseases. The excessive use of cane sugar is believed by many able clinicians to be the cause of diabetes.

HONEY

It is quite possible that good results would follow the exchange of at least a considerable part of the cane sugar we consume for honey. This natural sweet is prepared from the nectar of flowers.

Again, the same authority says in one of his booklets, "The Simple Life":

Cane sugar should be eaten only in small quantity. Large quantities cause acidity and give rise to gastric catarrh, and indigestion. Sweet fruits, such as raisins and figs, honey and meltose or malt sugar, are natural and wholesome sweets and may be eaten freely.

Note what Prof. H. C. Sherman has to say about refined sugar being an extreme case of one-sided sugar under the head Honey, Mineral Constituents of, near the close of the article. See page 477.

HONEY, GRANULATED.—See Granulated Honey.

HONEY, HEAT EFFECT ON.—When honey is utilized for purposes that require heating to relatively high temperatures, as in the manufacture of candy or for baking, it is found to undergo decomposition at temperatures somewhat below that of a mixture of dextrose and levulose of approximately the same concentration as honey. In other words, the caramelization temperature of honey as a rule is lower than that of commercial invert sugar. This low caramelization temperature of honey must also be reckoned with when honey is heated to retard granulation or prevent fermentation. Often such treatment tends to impair the flavor as well as to produce some discoloration owing to slight caramelization.

From tests conducted in this laboratory on honeys of different floral sources, considerable differences were found to exist among the various types with respect to their tendency to caramelize when heated. The low caramelization temperature of honey is due partly to the presence of certain colloidal substances. (See Colloidal Substances in Honey.) The colloids isolated from honey were found to decompose to an appreciable extent when subjected to temperatures above 50° C. (122° F.). Honey that had been treated so as approximately to free it from colloids, however, was still found to be more subject to caramelization on heating than commercial invert sugar. Apparently then, other non-sugar substances present in honey besides colloids are responsible for its low caramelization temperature.

In a recent paper it was shown that, in addition to proteins, nitrogenous compounds of amino-acid character are present in honey. Since reducing sugars apparently interfere seriously with the development of the characteristic color of the ninhydrin reaction, it was found necessary to separate the amino acids from the reducing sugars of the honey before application of the test.

Because the presence of any considerable quantities of amino acids in honey would tend to promote darkening in color, due to melanoidin formation resulting from the reaction between amino acids and reducing sugars of the honey, it was thought that differences in behavior of various types of honey with respect to caramelization might be due, partly at least, to variations in the amino acid content. (See Honey, Filtration of.)

* * * * * * *

In 1922, Riffart (6) made a thorough investigation of the ninhydrin test as a quantitative method for determining amino acids and related compounds. He found the method to be suitable for detecting small amounts of amino acids colorimetrically, in some cases in a dilution of 1 to 340,000. He also studied the action of the reagent on a number of substances that might interfere with the reaction.

Ambler (1) has worked out a simplified modification of Riffart's method and applied it to the determination of amino acids and related compounds in sugar products. The presence of sucrose does not

affect the reaction, and the method is very satisfactory and reasonably accurate. Attempts to apply the ninhydrin test directly to honey solutions, however, resulted in the development of a deep brownish red color and upon dilution no characteristic violet color was obtained. In a recent article Ambler and Snider (2) showed that the presence of reducing sugars in appreciable amounts—namely, more than 1 mg. of levulose or 10 mg. of dextrose—altered the typical violet color of the reaction mixture, and in cases where larger quantities of these sugars were present the characteristic color did not appear at all on dilution.—Material taken from article by R. E. Lothrop and S. I. Gertler, Bureau of Chemistry and Soils, Washington, D. C., published in Industrial and Engineering Chemistry (Analytical Edition, vol. 5, p. 103, March 15, 1933.)

HONEY-HOUSE.—See Buildings and Extracting.

HONEY ICE CREAM.—During the Great War when sugar was scarce and could not be obtained in quantity, the manufacturers of ice cream adopted honey as the only sweet that could be substituted for sugar. Honey during the latter part of the War was selling in carlots from 18 to 25 cents per pound and the makers of ice cream were glad to get it even at these prices. It was demonstrated that honey could and did make a very superior article. The products were sold under various trade names such as Orange Blossom Honey Ice Cream and Sweet Clover Honey Ice Cream, and the public took them even at the higher prices. Hundreds of carloads of honey during that period went into ice cream. It was believed at the time that honey would be a permanent sweetening agent in connection with sugar but the fondest hopes of beekeepers for a new outlet for their product were turned into disappointment. Shortly after the Armistice was signed honey prices of 18, 20 and 25 cents in carlots began to tumble and soon honey ice cream disappeared from the market, as sugar in any quantity could be had for so much less; but this was probably not the only reason for the change back to sugar. There were others. As these reasons are still fundamental they should be given here. First, a straight honey ice cream with no other sugar is too rich or too sweet and would cloy the appetite against more. Second, honey has so pronounced a flavor that other flavors like vanilla are either obscured or lost. Third, a cream with only honey as a sweetening agent takes longer to freeze and a lower temperature to hold the cream to the proper consistency.

These reasons are to a large extent valid today and yet it is possible to make a honey ice cream that is delicious, does not cloy the appetite and yet costs little if any more to make. All of these reasons can be met by using sugar with the honey. Either cane or corn sugar can be used with honey to reduce the cost or the flavor of honey so that it is not so pronounced. Milk powder (evaporated milk) skim milk powder or condensed milk is often used in regular ice cream to reduce the cost and at the same time its sweetness. A milk powder, or even a skim milk powder, with low sweetening power, is especially adapted for reducing the sweetness of a honey candy or a honey ice cream.

Before giving formulas using honey, some general principles that enter into the making of ordinary ice cream should be given. In an excellent bulletin on how to make honey ice cream, No. 345, of the Agricultural Experiment Station for the University of Illinois, we find this:

General Procedure for Commercial Ice-Cream Manufacture

Ice cream is made from such a mixture of milk, cream, condensed milk, or other dairy products, and sugar as will result in the desired proportion and concentration of the different solids. The butterfat content usually varies from 8 to 16 per cent (by weight); the milk-solids-not-fat, from 9 to 13 per cent; and the sugar, from 12 to 18 per cent, depending somewhat

TABLE 2.—EFFECT OF HONEY SWEETENING ON FREEZER OPERATIONS

Mix	Fat pct.	Tot. solids pct.	Cane sugar (by wt.) pct.	Honey (sweet clover) pct.	Time brine was on* min.	Tot. time to freeze (100% over-run) min.	Temp. when brine was shut off °F.	Temperature at 100% overrun °F.
1	13.27	35.58	14.0	0	5	8.50	26.0	25.5
2	13.42	36.45	10.5	4.5	5½	11.25	25.1	24.6
3	13.19	36.70	7.0	9.0	6	11.75	23.5	23.2
4	13.20	36.44	3.5	13.5	6½	13.00	22.6	22.5
5	12.90	36.42	0	18.0	6¾	13.25	21.6	21.8

*Brine temperature, 9° F.

on the kind ot sugar used. A stabilizer such as gelatin is usually added for the purpose of improving the body of the ice cream.

The ice-cream mix is ordinarily heated to 145° to 160° F. for about 30 minutes for the purpose of destroying bacteria, and is then passed through a high-pressure machine in order to completely emulsify the butterfat. It is then cooled rapidly to about 40° F., at which temperature it is held until frozen. Holding the pasteurized mix at a low temperature is called aging and usually lasts for 24 to 48 hours.

In freezing ice cream it is the usual practice to lower the temperature of the mix in the freezer until the maximum amount of heat is removed that will permit the incorporation of the desired amount of air. The refrigeration is then shut off and the ice cream whipped until the desired increase in volume, or "overrun" as it is termed, is obtained. Ordinarily from 80 to 100 per cent overrun is secured. Flavoring is usually added at the freezer.

The finished ice cream is drawn from the freezer into conveyors, cans, or pans for bricks, and is then placed in a room having a temperature of 0° F. or lower, where it is allowed to harden before being marketed.

* * * * * * *

Flavor Combinations

Various flavor combinations were tried with ice creams sweetened with 16 to 18 per cent sweet-clover honey. Pure vanilla extract did not blend well with the honey flavor, while chocolate covered it up almost entirely. Pineapple fruit was found to produce a very pleasing flavor. Cherry, peach, mint, and tutti-frutti made satisfactory combinations. Cold-pack strawberries did not blend so well as did some of the other fruits. One of the best combinations found was bisque made with grapenuts.

* * * * * * *

Effect on Freezer Operations

Since honey lowers the freezing point of a mix to a greater extent than does an amount of cane sugar of equal total solids, it might be expected that there would be some differences in the freezer operations. This relationship as outlined in Table 2 shows that as the proportion of honey was increased, the time required for the brine to be on was increased. There was also a tendency for the honey mixes to require a longer time to whip. Examination of the freezing curves, however, shows that when the ice cream was drawn at an overrun of less than 100 per cent, the differences in the freezing periods became less. Some manufacturers limit the overrun in package ice cream to 80 per cent. In these freezings 80 per cent overrun would have been obtained at the following intervals:

Mix.	Minutes to reach 80% overrun for drawing.	Temperature at 80% overrun.
1	6 - 7	25.5° - 25.4° F.
2	7 - 8	24.6° - 24.5° F.
3	8	22.8° F.
4	8 - 9	21.9° F.
5	8 - 9	21.2° F.

Summary and Conclusions

Honey can be used satisfactorily to replace 50 to 100 per cent of the sugar in an ice-cream mix, and in these proportions gives so distinct a flavor to the ice cream that a new and pleasing variety is obtained.

A more pronounced honey flavor is obtained by the complete replacement of the sugar with honey, but because of freezing difficulties a 75 per cent replacement is likely to prove more practical. The minimum amount of honey which will give an appreciable honey flavor to the ice cream is 9 per cent, but a more desirable flavor will result from the use of 14 to 18 per cent. When used as the sole sweetening agent, 16 to 18 per cent honey by weight is sufficient to sweeten and flavor the mix. Since honey is not so sweet as sugar, it must be used in greater proportions. Assigning a sweetening value of 100 to cane sugar, honey has a value of about 70 to 75 per cent. (See Honey, Sweetness of.)

The average percentage of total solids in the fourteen samples of honey studied was 81.305, the minimum, 75.37, and the maximum, 91.86, as determined by the Mojonnier method.

Since ice-cream mixes containing honey have a lower freezing point than those containing sugar, they freeze and whip more slowly. Lower temperatures must be maintained in the hardening room for the honey ice cream in order to keep it in a firm condition. Ice creams containing honey melt more rapidly at room temperatures than do those containing sugar.

In comparing ice creams sweetened with cane sugar with those sweetened with honey, little difference could be noted in body when the total solid content of the mixes was the same. The honey ice cream seemed to be slightly smoother but had a tendency to be somewhat crumbly.

TABLE 4.—FORMULAS FOR FOUR ICE-CREAM MIXES WITH HONEY USED FOR SWEETENING (Expressed in pounds needed for 100 pounds of mix).

	Mixes containing 10% fat, 12% serum solids				Mixes containing 14% fat, 10% serum solids			
Percentage of non-milk products*	14.5	17.5	18.5	21.5	14.5	17.5	18.5	21.5
Combination of milk products								
A								
40% cream	19.54	19.24	19.14	18.85	31.30	31.00	30.90	30.61
Skim milk	38.68	34.49	33.09	28.89	35.71	31.52	30.12	25.93
Bulk condensed (8% fat, 27% serum solids	27.28	28.77	29.27	30.76	18.49	19.98	20.48	21.96
B								
32% cream	23.06	23.58	23.73	24.21	37.10	37.60	37.76	38.23
4% milk	49.92	45.76	44.56	40.72	37.41	33.60	32.32	28.56
97% powdered skim milk	4.52	5.16	5.21	5.57	2.99	3.30	3.42	3.71
Evaporated milk (7.8% fat, 17.7% serum solids)	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
C								
83% butter	8.62	8.79	8.83	9.01	13.59	13.78	13.82	13.99
4% milk	71.11	67.61	66.50	62.95	67.90	64.45	63.28	59.76
87% powdered skim milk	5.77	6.10	6.17	6.53	4.01	4.33	4.45	4.75
D								
32% cream	26.61	27.32	27.43	28.03	39.89	40.49	40.69	41.30
4% milk	37.12	32.24	30.56	25.76	30.88	26.08	24.48	19.60
32% concentrated skim milk	21.77	23.04	23.51	24.71	14.73	15.93	16.33	17.60

*The non-milk products include, in addition to the sweetening agent, gelatin and, if needed, water for dissolving the gelatin. Ordinarily about ½ per cent of gelatin is used, the exact amount depending upon its strength. About 3 pounds of water will be needed for dissolving the gelatin in 100 pounds of mix in case it is not added to the dry form.

Mixes containing honey can be successfully pasteurized.

The flavor of honey ice cream varies with the flavor of the honey used. The ice creams in which alfalfa and clover honey were used were the most popular with the judges.

Most of the fruits commonly used to flavor ice cream combine successfully with honey. Vanilla extract, however, does not blend well with it.

Honey ice creams can ordinarily be stored for several weeks without injury to the flavor. There were a few instances, however, in these experiments when a stale flavor developed. The beeswax added in the honey did not seem to be a factor in this flavor defect.

On the basis of the ingredient costs assumed, a honey ice-cream mix costs about 4 cents a gallon more than a mix flavored with pure vanilla and sweetened with sugar. The cost, however, is about 11 cents less a gallon than that of the average fruit mix.

Formulas for Honey Ice Cream

Variations in the kind of milk products available, differences in the proportions of non-milk products that can be used, and the large number of combinations of fat and milk-solids-not-fat possible in the finished ice cream make it impractical to give a complete set of honey ice-cream formulas. Those given in Table 4 will, however, provide the reader with a fairly comprehensive list to choose from.

The table lists four possible combinations of milk products under A, B, C, and D and shows how many pounds of each are needed in 100 pounds of mix when using either one of two combinations of fat and milk-solids-not-fat. These two groups are again divided into four, which vary in percentage of non-milk products from 14.5 to 21.5.

When a mix is desired the composition of which lies between the extremes listed in the table, the correct proportions can be calculated from the formulas given. For example, if the mix is to contain 12 per cent fat, 11 per cent m.s.n.f., and 14.5 per cent non-milk products, and the milk products available are as listed under A, the formula can be calculated by averaging the values given for the 10-12 and 14-10 mixes as follows:

	10-12 mix	14-10 mix	Average 12-11 mix
Cream	19.54	31.30	25.420
Skim milk	38.68	35.71	37.195
Condensed milk	27.28	18.49	22.885
Total milk solids	85.50	85 50	85.500

Table No. 4 does not show the amount of sugar or honey. This comes under the heading of "Percentage of non-milk products." This includes sugar and a small percentage gelatin to give the cream more body. The figures 14.5 to 21.5 are almost entirely sugar or honey. The larger percentage of honey, the stronger the honey flavor. If too much honey is used the cream will be too rich or too sweet and cloy the appetite.

Tebbit's Medina Honey Ice Cream

The honey ice cream sold by the Pritchard Honey roadside stand north of Medina that has given such general satisfaction, is made by the Tebbit's Ice Cream people of Medina. It is neither too rich nor too sweet. It is just right. Mr. W. R. Koons, manager for the Tebbit's Ice Cream, has kindly given us the formula, which uses, as will be noted, an equal amount of sugar and honey. Here is is:

Butter fat	12 %
Serum solids	10½%
Sugar	7½%
Honey	7½%
Egg yolk solids, not fat	1 %
Gelatine	½%

Use no other flavor or color than the honey. This cream will require colder temperatures and will stand an overun of 100 per cent.

There will be some who will prefer perhaps a cream using honey only as the general sweetening agent. Prof. P. S. Lucas, associate professor of dairy manufactures of Michigan State College, has worked out some formulas that use all honey. In Gleanings in Bee Culture, page 225 for the year 1931 he writes:

Honey Serves as Combined Sweetener and Flavoring Agent

Several formulae are possible employing hon-

ALL HONEY ICE CREAM FORMULAS

MIX 1: 8.2 PER CENT FAT.

Pounds.	Ingredients.	Pct. fat.	Lbs. fat.	Pct.serums solids.	Lbs.serum solids.	Pct.total solids.	Lbs.total solids.
336.9	Cream	20	67.4	7.2	24.3	27.2	91.6
365.7	Milk	4	14.6	8.64	31 6	12.64	46.2
48.0	Skim milk powder			95.0	45.6	95.0	45.6
243.6	Honey					81.6	198.8
6.0	Gelatin					90.0	5.4
1000.0		8.2	82.0	10.15	101.5	38.8	387.6

MIX 11: 10.2 PER CENT FAT.

Pounds.	Ingredients.	Pct. fat.	Lbs. fat.	Pct.serums solids.	Lbs.serum solids.	Pct.total solids.	Lbs total solids.
464.0	Cream	20	92.8	7.2	33.4	27.2	126.2
236.4	Milk	4	9.5	8.64	20.4	12.64	29.9
50.0	Skim milk powder			95.0	47.5	95.0	47.5
243.6	Honey					81.6	198.8
6.0	Gelatin					90.0	5.4
1000.0		10.2	102.3	10.13	101.3	40.8	407.8

MIX III: 12.3 PER CENT FAT.

Pounds.	Ingredients.	Pct. fat.	Lbs. fat.	Pct.serums solids.	Lbs.serum solids.	Pct.total solids.	Lbs.total solids.
594.2	Cream	20	118.8	7.2	42.8	27.2	161.6
104.2	Milk	4	4.2	8.64	9.0	12.64	13.2
52.0	Skim milk powder			95.0	49.4	95.0	49.4
243.6	Honey					81.6	198.8
6.0	Gelatin					90.0	5.4
1000.0		12.3	123.0	10.12	101.2	42.8	428.4

ey as the combined sweetener and flavoring material. One of the simplest which may be used either in the factory or home is made up of

40 pounds 20 per cent cream,
15.7 pounds honey.
4 ounces gelatin.

To prepare the ingredients the gelatin is melted in water, stirred into the mix, after which the honey is added and stirred until dissolved. Little difficulty was experienced in dissolving the honey. If the mix is to be pasteurized the honey may be added to the mix when the temperature has reached 90° F. Since honey does not color the mix enough, color should be added to give a light lemon shade.

The above mix will show in the finished ice cream 13.2 per cent fat, 4.75 per cent serum solids, and 39.46 per cent total solids. If an identical mix were made using nine pounds sugar instead of honey and adding four ounces vanilla it would contain 14.83 per cent fat, 5.34 per cent serum solids, and 36.5 per cent total solids. Because of the additional solids in the honey mix it would be possible to incorporate more overrun. Figuring butterfat at 70 cents per pound, honey at 10 cents, sugar at six cents, gelatin at 40 cents, and the weight of each mix at nine pounds per gallon, the honey mix costs $1.17 per gallon, the sugar mix $1.19.

When vanilla was used in the honey mix the blend of flavors was unsatisfactory. There are flavors such as lemon or orange which probably would produce a better blend.

Honey mixes froze normally with the exception of time required for freezing. The freezing time was prolonged making the expense of freezing somewhat greater. The body and texture of the finished ice cream were very fine.

For the commercial ice cream manufacturer the following three mixes have been calculated. These will meet the requirements of practically all states, the first containing 8.2 per cent fat, the second 10.2 per cent fat, and the last 12.3 per cent. Because of the use of higher per cents serum solids the total solids are somewhat higher than the formula given above, assuming fat per cent to be the same. No special precautions need be taken in processing these mixes. Each carries a 14 per cent sugar equivalent.

These formulas the author believes could be improved by decreasing the amount of honey and adding sugar. There will then be a strong enough flavor of honey. The proportions of honey to sugar can best be determined by experiment.

HONEY IN INFANT FEEDING.—While it is admitted, of course, that breast milk from a normal mother is the best possible food for human babies, this natural food is often deficient in quality and quantity for the baby, especially as it grows older. It is then that modified cow's milk must be given to take the place of or supplement mother's milk. Various sweetening agents have been used to make the cow's milk come more nearly to the requirements of the human baby. Glucose (dextrose) or dextri-maltose have been the sugars most commonly used for the purpose. Some recent work goes to show that honey, while more expensive than glucose, is much cheaper than dextri-maltose and superior to either for modifying cow's milk. It has been hard to get the medical fraternity to recognize the virtues of honey for infant feeding, but some of the leading physicians and child specialists in this country and Europe are beginning to see the light and are not slow to let their brother physicians know.

Among the first to recommend honey for children was Dr. Paul Luttinger, Bronx Hospital, New York City, and a lecturer on child diseases. He writes a lengthy article on the virtues of honey especially for children, in the New York Medical Journal and Medical Record for August 2, 1922. From it we make the following extracts:

> Honey is indicated in any condition of the intestinal tract where the assimilation of starch or the disaccharides is delayed and where prompt absorption of energy is desired. In constitutional inability to digest starch or other polysaccharides, due to lack or diminution of the respective enzymes, honey is a boon indeed. A solution of honey in water (one teaspoonful of honey to a glass of water) is almost as quickly absorbed as alcohol, and its effect is more lasting. I, therefore, prefer it to alcohol, especially in broncho-pneumonia. For a long time I hesitated prescribing honey in inflammatory conditions of the intestinal tract, such as gastroenteritis, owing to the danger of pollen sensitization; but it was given unintentionally in one case, and, as there were no ill effects observable, I have continued using it in all cases of summer diarrhea in the proportion of one teaspoonful of honey to eight ounces of barley water.
>
> The largest part of the honey sugar is fructose (levulose), a levorotatory monosaccharide which seems to have a peculiar affinity for the body cells; thus it is rarely, if ever, found in the urine of diabetic patients. It is more rapidly absorbed than lactose and it has not the disadvantage of undergoing butyric acid fermentation like maltose; hence it does not produce acidosis. Its rapid absorption prevents it from undergoing alcoholic fermentation, and infants fed on honey rarely show signs of flatulence.
>
> * * * * * * *
>
> The importance of mineral salts is too well known to need discussion, and although honey contains only small amounts, they are of great value to infants. This is especially true of the iron which human as well as cows' milk contains in exceedingly small quantities. Honey complements this deficiency. (See Honey, Mineral Constituents of.)
>
> The organic acids, which in some specimens go up as high as two per cent, and are rarely less than one per cent, act as mild stimulants to the digestion; and the increase of appetite seen in children fed on honey may be largely ascribed to this factor and possibly to the volatile oils. Children fed on pure honey can easily dispense with orange juice.
>
> I have had no occasion to observe the many vaunted curative powers of honey. The 419 cases in which I have used honey were mostly feeding cases; but I did observe that fresh honey, especially virgin honey directly obtained from the honeycomb, has a decided laxative action which it loses upon boiling. Secondly, fresh honey seemed to have a pronounced soothing effect upon infants. Honeys with strong aromas exhibited this action to a greater extent than those which were comparatively odorless. Those who were fretful before exhibited a remarkable change of temper after being put on honey. The tendency to fall asleep after feeding was greatly increased.

The following regarding the use of honey for babies is taken from a leaflet of the American Honey Institute, which leaflet bears the seal of Acceptance of the American Medical Association. It reads:

Most sugars must be broken down into simple sugars by digestion before they can be assimilated. The simple sugars resulting are identical with those found occurring naturally in honey. For this reason honey requires practically no digestion. It is almost wholly available for immediate absorption into the body. This is one reason why it is recognized as a valuable food for babies and growing children.

Clarence W. Lieb, M. A., M. D., a child specialist of New York City, in his book, "Eat, Drink and be Healthy," shows the dangers of refined sugars, and recommends honey and fruit juices instead, especially for children. The cane and beet sugars, he says, require too much digestive energy to convert them to simpler forms for absorption. In fact, he believes they irritate the stomach and retard digestion.

The following references on honey for infants which were prepared by the Bee Culture Laboratory, Department of Agriculture, will show pretty conclusively that honey is a good sugar for small children.

Baby Hospital Where Honey Is Used

The experience of the baby hospital in New Jersey under the direction of Dr. O'Gorman proving the merits of honey as a safe and sane sweet for babies is especially convincing.

Mothers' Institute, Jersey City, New Jersey. A baby hospital at this Institute under the direction of Dr. M. W. O'Gorman, Chief of the Division of Child Hygiene, Department of Public Affairs of Jersey City, N. J., that for five years has modified the milk of its babies with honey alone and with complete success, never having occasion to change, is of interest to every mother. When one considers that every infant admitted to this institution has been suffering from acute malnutrition, poor, struggling mites that looked as though they had little chance to survive, the fact becomes even more impressive. A diet consisting simply of whole milk, skimmed and boiled and modified with honey, helped restore those babies to vigorous health. They received orange juice, tomato juice, fresh cooked vegetables and fresh scraped raw vegetables, scraped bananas, vegetable broth and cottage cheese, cereals and other foods that the medical profession recommends for infants as they get ready for them, but they all start with milk and honey. There was no experimental period. To begin with they received ½ teaspoonful honey to each twenty-four-hour feeding. This is quickly increased until they are getting from 1½ to 2 teaspoonfuls according to their size and especially according to the character of their stools. Honey is gently laxative. The babies can be given honey up to the point where their bowels are too loose. Should they become constipated, increase the amount of honey ¼ teaspoon. If the opposite condition exists, decrease the amount of honey ¼ teaspoon.

Dr. O'Gorman, to whom we wrote asking if he were still using honey to modify his milk at the baby hospital, writes as of September 26, 1934, as follows:

In the past twenty-five years we have found this natural carbohydrate (honey) a valuable and a very satisfactory addition to our milk modification in infant feeding and in the growing child's dietary.

Other References

Here are a few more references from the Bee Culture Laboratory, Washington, D. C.:

Archives of Pediatrics, January, 1925. "Selection of Sugars in Infant Feeding," by Randolph G. Flood, M. D. "In honey we have a composite mixture of dextrose and levulose with the latter predominating as all American honeys are levoratory. Honey owes its ease of absorption to the free available dextrose to the mixture, and its laxative action to the levulose faction, which is slowly absorbed so that it eventually reaches the large intestine. These properties make honey a very valuable sugar in the treatment of constipated bottle fed infants, and in our hands have benefited these children a great deal."

Acts Sociatatis Modicorius Peanicae Duodecia, November 18, 1931, issue, article on "Use of Honey instead of Sugar in Infant Feeding." This report finds honey superior in infant feeding. The infants gained more in weight, showed no tendency toward diarrhea and were completely normal as long as kept on this diet.

"Bulletin de la Societe de Pediatric de Paris," April, 1931, issue. Article on "Honey in Normal and Therapeutic Diet in Infants." The investigator states that the sugars of honey are tolerated admirably by the digestive tracts of very young infants and that honey is a powerful "anti-putride" (the French equivalent of an agency that is anti-putrefactive.)

Bienenstein, Erwin, 1932. Ueber die Verwendung des Honigs als Diakost nierenkranker Kinder. Bienen-Vater 64:18-19. Reports use of honey instead of sugar in the treatment of children's kidney diseases in a certain hospital in Vienna.

Dr. Bodog F. Beck of New York City, author of the book, "Bee Venom and Its Nature and Effect on Arthritic and Rheumatoid Conditions," also author of "History and Use of Honey," in the last mentioned, says:

The medicinal value of honey is one of its important features. Without any doubt, honey should have more attention in the feeding of invalids and infants, because next to milk it is the best food for children. The old Gaelic honey was reputed to be better for children than any other tonic. The Scotch believed that honey-suckle, a favorite of the bees, contained some life substance. Unquestionably honey is easily digested. Many cases of dyspepsia and Bright's disease could have been avoided by the use of honey instead of sugar.

Infants fed on honey rarely show flatulence. In marasus, rickets and scurvy, in fact, in every case of malnutrition, it is simply a "sin qua non," because it contains not only proteins but mineral salts and vitamins which are missing in sugar. The nomadic Arabs, the Bedouins, even today feed their children with buttermilk and honey. Important anti-tuberculous effects are attributed to honey by peasants of all countries. The spiced honey of the Turks is well known.

As a laxative, honey is "par excellence." A teaspoonful as sweetening in a cup of hot coffee or tea instead of sugar is the best natural daily laxative. A tablespoonful of honey in a

glass of barley water will serve the same purpose.

Still Further References

Under head of Honey, Food and Medicinal Value, will be found more references. See pages 460, 462, 464, 465.

How to Prepare the Milk Honey Formulas for Babies

In the bee journal, "Bees and Honey," published at Alhambra, California, Dr. W. Ray Jones, an authority on the use of honey in baby feeding, writes:

When making use of the following formulas for modified milk using honey as the carbohydrate instead of sugar, one must not lose sight of the fact that these are for the average baby in good health. No modified milk can completely substitute for mother's milk. The formulas here given are intended to supplement breast feeding when the natural milk is insufficient.

For a working basis consider the child as obtaining all nutrition from the bottle. The baby requires a definite number of calories per pound of body weight, averaging 45.5 calories per pound for the first six months. Weights and capacities are averages, so feeding must be varied in quantity depending upon the size of the baby.

In caloric feeding we consider an ounce of fat as furnishing 270 calories, cream (16% fat) 52 calories, and sugar and protein each 120 calories. Honey furnishes approximately 100 calories per ounce, on an average.

All the following formulas are averages for the total 24 hours feedings, and must be adapted to the individual requirements. Quantity at a feeding should be less than stomach capacity.

Formula No. 1—Birth to three weeks, weighing 7 pounds, requiring 318 calories; stomach capacity, 1 to 3 ounces: Whole milk, 13 ounces; water, 12 ounces; honey, 5 drachms.

Formula No. 2—Three to 6 weeks, weighing 8 pounds; capacity, 3 to 4 ounces: Whole milk, 14 ounces; water, 10 ounces; honey, 7 drachms.

Formula No. 3—Six weeks to 2 months; stomach capacity, 4 to 5 ounces, weighing 10 pounds: Whole milk, 17 ounces; water, 15 ounces; honey, 1¼ ounces.

Formula No. 4—Two to 4 months, weighing 11 pounds; stomach capacity, 5 ounces: Whole milk, 19 ounces; water, 16 ounces; honey, 1¼ ounces.

Formula No. 5—Four to 6 months, weighing 12 pounds; capacity 6 ounces. Whole milk, 22 ounces; water, 14 ounces; honey, 1¼ ounces.

Formula No. 6—Six to 9 months, weighing 14 pounds; 8-ounce stomach capacity: Whole milk, 26 ounces; water, 12 ounces; honey, 1¼ ounces.

Formula No. 7—Nine to 12 months, weight, 17 pounds; feeding, 8 ounces: Whole milk, 36 ounces; water, 5 ounces honey, 1 ounce.

Probably a more practical, though less exact way, would be to use the ordinary Hygeia bottle, making only 8 ounces at a time. From 4 months on, the baby can be fed only what proportion is needed at a feeding, discarding the remainder, and making fresh for next feeding. Four-hour feedings are best with 3 hours permissible. Under no condition feed the baby every time it acts hungry.

Formula A—Four months, 11 pounds, one feeding (will not take all): Whole milk, 4 ounces; water, 2 ounces; honey, 1¼ drachms.

Formula B—Six months, weighing 18 pounds, one feeding: Whole milk, 6 ounces; water, 1½ ounces; honey, 1¼ drachms.

Formula C—Nine months and over, one feeding: whole milk, 7½ ounces; honey, 1 drachm.

In other words, a teaspoonful of honey to a bottle of milk for 9 months and over. Feed every 4 hours, and supplement with other foods.

In measuring quantities a 4-ounce graduate, or a graduate nursing bottle, is a necessity. The ordinary teaspoon is supposed to hold one drachm. A dessert spoon holds two teaspoonfuls or one-fourth ounce; a tablespoonful, two dessert spoonfuls or four teaspoonfuls—half an ounce. Spoons are however, not always made accurately.

The great and perhaps the only disadvantage is the tendency for the child to overeat. Honey-milk is too tasty. Overfeeding is much worse for the baby than underfeeding.

Honey differs in several ways from milk modifiers. It is already dextrose and levulose, thus requiring no digestion. It contains vitamins, if fresh and has not been heated too much. No other ordinary carbohydrate modifier contains vitamins. It is cheaper than any of the others except corn syrup and cane sugar. Being pre-digested it is absorbed before fermentation can take place. It can not cause diarrhea.

HONEY, MINERAL CONSTITUENTS OF.—Analyses of honey show that it contains a variable amount of inorganic material, usually expressed as "ash." This term is used because, in determining the mineral constituents, the water and the carbohydrates and other organic parts are driven off or consumed at high temperatures and the inorganic portions remain as the ash of this combustion.

The animal body contains a considerable amount of mineral matter, and this is taken in with the food. It is, then, clear that the sum total of the food ingested must contain adequate amounts of these materials. Muscle tissue, for example, contains from one to three or four per cent of mineral materials, fat somewhat less, while bone is high in such elements. Certain of the inorganic substances are constantly being taken into and eliminated from the body, while others, as the calcium of bone, is retained in body tissues. There is, of course, a constant elimination of mineral salts in excretion.

According to the official definition of honey used by the Federal Department of Agriculture in the enforcement of the Food and Drugs act of June 30, 1906, honey should contain not to exceed one-fourth of one per cent of ash. Browne, in his well-known work on the analysis of American honeys, found that certain excellent honeys exceed this limitation, and it is therefore not to be expected that honey will be barred from the market if it exceeds the limits in ash content. The average found by Browne for all honeys examined was 0.23 per cent, and he found honeys of the dextrorotatory type containing as high as 0.90 per cent ash. The lowest percentage of ash in any honey ex-

amined by him was 0.03, this being a fruit bloom honey from Maine. As a rule, so nearly as can be told from a casual examination of his results, northern honeys and those light in color have a lower ash content than southern or darker honeys. Honeydew honeys usually have a high ash content, one sample examined by Browne reaching 1.29 per cent. Aside from the determination of the rotation of polarized light, the ash content is often a useful test in distinguishing honeys from honeydew honeys.

Source of Mineral Matter in Honey

Plants, like animals, require inorganic constituents, and these must pass in solution from place to place within the plant in the sap. It is, then, not surprising that, when nectar is elaborated from the sap, some of the soluble mineral elements pass through the filter of the nectaries into the material which the bees later gather. These stable materials are unmodified in the ripening process; and, while they are present in nectar only in minute amounts, the elimination of water in ripening increases the percentage to that found in honey. But the plants are not the ultimate source of these materials, for the plants derive them from the soils in which they grow. It is therefore not surprising that the salts of honeys vary according to the soils from which they are derived.

It is also an interesting thought that, of all the material which enters into honey, these mineral materials are the only ones which are necessarily derived from the soil. The water may enter the plant through the roots, but in its pure state it does not rob the soil of any fertility. The carbohydrates in honey are manufactured in the plant by the action of sunlight and chlorophyll on carbon dioxide and water, and this is no drain on fertility. The salts alone are permanently removed. Other crops are considerably higher in ash content, and in various types of fertilizer an effort is made to replace those which are removed to a serious extent; but in the production of honey the removal of important soil constituents is reduced to a negligible degree. We shall see, however, that the minerals removed from the soils add greatly to the value of honey as an article of human diet.

Being soluble in nectar, these salts remain in solution in honey. When granulation of honey occurs, they are not crystallized out but remain in solution in that portion of the water which is not incorporated in the dextrose crystals. These materials are even more readily soluble than the sugars in honey. Some years ago, in some investigations on honey, the honey was diluted and forced through sheets of celloidin by vacuum pressure. The first materials to pass through were the salts, since the molecules of these are smaller than those of either the sugars or the coloring materials in honey.

Bees require a considerable amount of mineral material for their own development. Only a few analyses seem to have been made of the ash of adult bees, but Aronssohn dried adult bees and from 100 grams of this dried material he obtained 4.23 grams of ash. This one analysis showed the presence of sulphur, chlorine, iodine, phosphorus, arsenic, silica, copper, iron, manganese, zinc, aluminium, calcium, magnesium and possibly fluorine. If space permitted, it would be interesting to discuss these findings. Traces of arsenic being found, naturally the question was raised whether the bees had obtained it from spray poisons, but the author stated that no spray material was used in that region. Copper was found in small quantities, and this is highly poisonous to many forms of life. In insects and crustaceae, however, copper forms a component of the blood, taking the place of iron in the blood of vertebrate animals. Lederle made similar analyses of bees in Germany and found relatively large amounts of calcium and of phosphoric acid. A similar analysis by Breiden also showed a predominance of these materials in the ash of adult bees. Bees might get some of this mineral material from honey, but there is also the possibility that they get parts of it from pollen. An examination of the ash of adult bees does not, therefore, give us much indication of the ash content of honey, since some minerals would be retained and others eliminated. Bees might get more than adequate amounts of calcium from hard drinking water, and this would not necessarily come to them through either honey or pollen.

When bees are wintered on sugar syrup with no honey, there is no possibility of their obtaining vitamins. Similarly such a winter diet provides no mineral salts. Whether these elements of their food are especially necessary during the

growth period of the larva, as seems probable, or whether bees actually need continuing sources of such elements is still to be determined. If they require a constant supply of salts, they are not getting it on a sugar-syrup diet. There is room for some interesting work here. (For a further discussion of minerals in honey, see Honey, Food Value of, and Honey, Filtration of.)

Value of Mineral Material in Human Diet

A vast amount of work has been done on the significance of mineral materials in the diet, and some most amazing things have been discovered. It is, for example, known that goiter is prevalent in regions where there is a deficiency of iodine in drinking water, and in such regions the addition of minute quantities of iodine to the water supply of towns and cities has resulted favorably in reducing or eliminating this disease. This occurs in spite of the fact that iodine is absent from many body tissues and that it is a highly poisonous element if taken in anything except minute amounts. It is known that, in addition to the usual ingredients of our food, carbohydrates, fats, and protein and other organic compounds, mineral substances are of prime importance. Some of these enter the body and remain as compounds with organic substances, in which case they are not detectable except by analysis. Others, like common salt, are taken into the body as such.

At least eighteen different elements in addition to carbon, hydrogen, oxygen, and nitrogen have been found in tissues of various animals and plants, but not all of them occur in all species. Sodium, potassium, calcium, magnesium, iron, phosphorus, sulphur, and chlorine are found in all living tissues, the other ten being found occasionally or only in certain animal or plant groups. Some of them have not been found to be necessary elements of living tissues, while others are vitally necessary. As has been stated, copper is poisonous to many animals, but essential to certain lower forms as a constituent of the blood. It is, of course, well known that common salt (sodium chloride) is essential to man and animals, and that a region where this is unavailable is often one of great physical suffering.

To discuss in detail the requirements of animals for each of the essential minerals is impossible. Iron is, of course, necessary in blood formation of the warm and red-blooded animals, but not so necessary for cold-blooded animals like insects and crustaceae which use copper in its place, having a different ingredient in the blood for carrying oxygen. Iron must, however, be in combination with organic materials, or be in organic union with them, to be utilized. Calcium is, of course, necessary for bone formation, and is vitally necessary to growing children; but it is interesting to note that an adequate amount of calcium may exist in the food and still bone formation may not progress satisfactorily unless one of the vitamins is present, or unless the growing animal is exposed to the rays of the sun. Chlorine is, of course, a necessity, since hydrochloric acid is employed in digestion. Sulphur is a constituent of certain proteins, and must therefore be available for their formation.

This discussion up to the present would suggest that salts are necessary as mere constituents of living matter, but their effect is more far reaching than this would indicate. It is impossible to go into a lengthy discussion of this subject, but the importance of salts may be indicated briefly. The cells of the body have become adjusted to a certain balance of salt solutions. These salts serve to maintain a suitable osmotic relation about the cells and provide a balanced solution in which they may carry on their reactions normally. Furthermore, these inorganic materials are electrically active, and this effect is essential for various bodily functions. For example, enzymes are inactive except in the presence of electrically active salts. The activity of the haemoglobin of the blood which serves to transport oxygen and carbon dioxide is greatly increased by the presence of salts. Secretion of some glands is impossible in the absence of such electrically active salts. The salts taken into the body enter definitely into the composition of living matter, and new salts must therefore be supplied when new tissues are to be built. Their effect is, however, more important in their activation of organic compounds which are primarily essential.

Honey More Valuable Food Because of Mineral Content

In the face of such statements of the mineral requirements, one naturally asks to what extent the mineral constituents of honey tend to make it a more desirable

food. The percentage is usually small as compared with other available foods. The percentage of ash of honey for example, is a quarter of the percentage of mineral materials in meats, or less, and usually somewhat less than that of milk. The important thing to learn seems to be what these mineral constituents are and whether they are of such a nature as to make them especially useful in the diet.

The following table sent out by the U. S. Division of Bee Culture, will show the minerals in honey as well as the other components:

THE AVERAGE CHEMICAL COMPOSITION OF HONEY

(Based on a sample 500 cubic centimeters, total weight, 725 grams (25.6 ounces.)

The Principal Components.

	Percent.	Grams.
Water	17.70	128.325
Levulose (fruit sugar)	40.50	293.625
Dextrose (grape sugar)	34.02	246.645
Sucrose (cane sugar)	1.90	13.775
Dextrins and gums	1.51	10.9475
Ash (silica, iron, copper, manganese, chlorine, calcium, potassium, sodium, phosphorus, sulphur, aluminum, magnesium	0.18	1.305
Total	95.81	694.6225

Alin Caillas, well known French honey chemist, in his recent excellent book, points out that honey contains calcium phosphate, iron phosphate, and states that he has made experiments to show that they are in such form as to be most readily absorbed, whereas apparently identical compounds prepared artificially are not thus easily absorbed. It is also interesting to note that this author finds the heather honey of the Department of the Landes in France generally the richest in these mineral constituents of any honeys examined so far. One honey from this part of France examined by him contained as much as 0.37 per cent of phosphoric acid and 0.17 per cent of iron as iron oxide. He states that this honey should receive special attention from the standpoint of its medicinal value. Caillas also found orange honey from Spain high in these ingredients and especially recommends it for medicinal use.

Some work done in 1932 by Prof. H. A. Schuette and Kathora Remy of the Laboratory of Foods and Sanitation, University of Wisconsin, goes to show that a deeply pigmented (darkly colored) honey is superior in nutritive value to one of light color and that the darker the honey the higher the mineral content. This would mean in other words that the greater the percentage of minerals the greater the nutritive value of the honey. No claim was made that this was a new idea, but rather that iron, copper, and manganese appear to predominate in the mineral matter of dark honey.

Several American writers on honey have emphasized the greatly added value as a food which the mineral constituents give to honey. Since these components come to honey from and through the plant, they are in such conditions as to be utilized as freely as are any such compounds, which is a point in favor of this contention.

Granulated sugar is virtually a chemically pure carbohydrate, containing no protein, no salts, no vitamins, no enzymes, none of the materials which occur in more natural production. One should exercise great care in making statements regarding the danger of consuming too great quantities of cane and beet sugar and of the superior merits of honey as a food, for such statements are apt to be misleading. The consumption of cane sugar has so greatly increased in the United States that we now exceed all other countries in per capita consumption. In 1924 (the last available statistics) this had reached the vast amount of 108 pounds, compared with less than half this amount a half century ago.

Experts in nutrition no longer place complete reliance on the calories which a food may supply, but using this method we find that this amount of sugar provides an average number of 532 calories per capita per day, which is well over one sixth of the bodily requirements for an adult. On several occasions when the statement has been made that we use an average of 108 pounds of sugar in this country, I have heard housewives insist that their families use no such extravagant amount. All this sugar does not enter the home as such. For example, it has recently been estimated that the average consumption of bottled soft drinks is 100 bottles per capita per year, in which will be hidden away over 4.5 pounds of sugar. The consumption of sugar in candies will reach a much higher average figure.

Professor H. C. Sherman has discussed the situation in the following terms: "Refined sugar constitutes an extreme case of a one-sided food, its sole nutritive function being to serve as a fuel, so that, as the energy requirement of the body is

met to a larger and larger extent by the consumption of refined sugar, there is a constantly increasing danger of unbalancing the diet and making it deficient in some of the substances which are needed for the building and repair of body tissues and for the regulation of physiological processes. Are we to assume that the ordinary dietary of the people of the United States furnishes such an abundance of all the essential elements and each specific necessary compound that a reduction in the intake through displacement of natural foods by refined sugar is of no consequence? The investigations of recent years indicate clearly that no such assumption is justified." (Food Products, The MacMillan Co., 1926, page 509.) (See Dangers from Refined Sugars at the close of the discussion on Honey, Food and Medicinal Value of.)

Add to this the vast amounts of commercial glucose and other artificially prepared and highly refined syrups and the situation becomes still more serious. Molasses, of all the readily available syrups, contains the most liberal supply of mineral constituents. By substituting honey in place of part of this orgy of sweetness, the danger pointed out by Sherman would be considerably reduced. But even the most enthusiastic advocate of honey would not be justified in recommending a consumption of 108 pounds of honey per capita per year, for that is too large an amount of sweet to recommend for a person desiring to remain in health.

It appears, then, that the mineral constituents of honey are of value in making it a better food than highly refined sugars and syrups. As previously stated regarding enzymes, the salts in honey are nature's trade mark of honey as a natural food. For this alone they are important, and the beekeeper is justified in placing some emphasis on this feature of honey in his discussions and conversations with his customers and friends.

Honey, an Alkaline-Forming Food

(By R. E. Lothrop, Carbohydrate Division, Bureau of Chemistry and Soils).

In addition to the question of the nature and quantity of mineral elements contributed to the diet by honey, we must consider the reaction of the minerals present, since this also is a dietary factor. By reaction is meant whether the minerals are predominantly acidic or predominantly alkaline in nature. The classification of foods as acid foods or alkaline foods is dependent almost altogether on the nature of the mineral elements present. Oranges, lemons, and fruits in general are quite acid to the taste, but as foods they are potentially alkaline. Like them, honey is also slightly acid to the taste, but as a food is potentially alkaline. This might seem somewhat paradoxical at first, but it is quite simple to understand if we consider what takes place when foods undergo digestion and metabolism in the body. Certain foods, such as oranges, lemons, and even honey, are sour or acid to the taste because they contain organic acids such as citric, malic, and others. Now these acids, along with sugars and starches present in foods, are very largely burned up in the body during digestion and metabolism. These acids, therefore, do not play a part in the acid-alkaline balance of the body. The reaction of the food then is dependent almost altogether on the mineral elements present.

Foods vary widely as potential sources of acid or alkaline products in metabolism. In general, meats, fish, eggs, bread, wheat, and the cereals contain a preponderance of acid-forming elements. Fruits, vegetables, and milk, on the other hand, contain a preponderance of alkaline-forming elements. The mineral content of commercial fats, sugars, and starches is too low to be of any significance from this standpoint.

There is no general agreement among food authorities as to the relative importance of the acid-alkaline balance of the diet. Some feel that the importance of maintaining somewhere near a balance between acid-forming and alkaline-forming foods, or of maintaining an alkaline balance in the diet, is greatly overstressed.

There is no record of any work having been done relative to the determination of the acid-alkaline balance of honey as a food. Many food authorities consider that the mineral content of honey is too small to be of much importance in the diet.

In order to obtain some definite information on various types of American honeys from this standpoint, an investigation was carried out by the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, utilizing a number of the more representative types of American honeys. The samples used in this work varied in color from water white to dark, as determined by the U. S. Standard honey color grader.

The method of Davidson and LeClerc was used for determining the acid-alkaline balance of the honeys. It consists of igniting a definite quantity (50 grams) of honey in a platinum dish under controlled temperature condition until all organic matter (sugars, etc.) is completely burned, leaving a white ash as a residue. This ash was found to be distinctly alkaline in case of all honeys studied. The ash is then neutralized with acid of known strength, the quantity of acid used being a measure of the alkalinity of the ash.

The value obtained in this way is not a true measure of the acid-alkaline balance of the honey, since part of certain mineral elements (chlorine and sulphur) is volatilized in the burning process and therefore is lost to the determination. The quantities of these elements lost in the ashing process must be determined separately, and a correction made in the value obtained by neutralizing the ash, in order to correct for the loss of these elements that occurs in burning.

The principle of this method of determining the acid-alkaline balance of foodstuffs is based on the assumption that in the processes of animal metabolism foods are undergoing combustion with ultimate effects approximating those that result from combustion either in an electric furnace or other equivalent heat.

All of the honeys tested in this manner gave definite alkaline values. With a few exceptions, the darker honeys gave higher alkaline values than the lighter varieties due to the generally higher ash content of the darker types. In consideration of the low mineral content of honeys in general, it might be interesting to note that alkaline values for some of the honeys studied compare favorably with some of the fruits and vegetables. Values for the various honeys studied are summarized in Table I. Tables II and III give comparative values of some common foodstuffs.

In conclusion, it might be stated that if the question of maintaining the proper acid-alkaline balance in the diet is important, then definite significance can be attached to the reaction of the mineral constituents of honey from this standpoint.

TABLE I.
POTENTIAL ALKALINITY OF HONEYS OF A VARIETY OF FLORAL TYPES

Floral type	Color number Pfund col scale.	Ash content pct.	Potential alkalinity (cc. normal alkali per 100 gms. honey)
Sweet Clover	0.6 (W. white)	0.04	0.27
Orange	1.2 (Ex. white)	0.05	0.50
White Clover	3.0 (White)	0.08	0.66
Sage	3.1 (White)	0.07	0.57
Tupelo	4.0 (Ex. lt. am.)	0.09	0.84
Mesquite	4.5 (Ex. lt. am.)	0.61	3.22
Catsclaw	8.5 (Amber)	0.22	1.86
Goldenrod	8.5 (Amber)	0.16	1.05
Tulip-poplar	11.5 (Dark)	0.30	2.68
Dark (unknown)	12.0 (Dark)	0.51	4.57
Buckwheat	13.5 (Dark)	0.10	0.42
Average:			
Light honeys		0.16	1.01
Dark honeys		0.26	2.12
All honeys		0.20	1.51

TABLE II.
POTENTIAL ALKALINITY OF SOME COMMON FRUITS AND VEGETABLES*

Food.	Approx. potential reserve alkalinity (cc. normal alkali per 100 gms.)
Apples	3.7
Asparagus	0.8
Bananas	5.6
Beans	14.0
Beets	10.9
Cabbage	6.0
Cauliflower	5.3
Celery	7.8
Citron	9.8
Cucumbers	7.9
Lemons	5.0
Lettuce	7.4
Mushrooms	4.0
Olives	45.0
Onions	1.5
Oranges	5.6
Orange juice	4.5
Peas	1.3
Peaches	5.0
Pears	3.6
Potatoes (white)	7.0
Potatoes (sweet)	6.7
Pumpkin	1.5
Radishes	2.9
Tomatoes	5.6
Turnips	2.7
Watermelon	2.7

TABLE III.
FOODS IN WHICH ACID-FORMING ELEMENTS PREDOMINATE*.

Food.	Approximate potential acidity (cc normal acid per 100 gms.)
Beef	12
Eggs	11
Oysters	15
Oatmeal	12
Rice	9
Wheat	12
Wheat flour	9
White bread	6

*Taken from Sherman's "Chemistry of Food and Nutrition," 4th Ed., p. 276 (1932), published by The Macmillan Publishing Co., New York, N. Y.

HONEY PLANTS.—The importance to American beekeepers of a thorough knowledge of the honey-producing flora of this country can not be overestimated. A beginning in this work has already been made by several states. An excellent preliminary list of Texas honey plants by Louis H. Scholl was published in 1908, and in 1911 there appeared a carefully prepared bulletin on the honey plants of California by M. C. Richter. In both these lists much attention is given to the geographical distribution within the state

limits of the species enumerated. More or less complete lists of the chief mellifluous plants of Massachusetts, North Carolina, Iowa, Oklahoma, and Arizona have also been prepared.

"Honey Plants of North America," by John H. Lovell, and "American Honey Plants," by Frank C. Pellett, are textbooks devoted to honey plants only.

No one should enter extensively upon the production of honey without first investigating the flora on which he must depend for a marketable surplus. Success or failure may often depend upon such information.

Geographical Distribution of Honey Plants

The geographical distribution of honey plants in the United States presents many striking peculiarities. While some occur over the entire county, others are restricted to a small area. The sumacs extend from the Atlantic to the Pacific; so do the carrot and carpetweed, though the latter is commercially most valuable in central California. Sweet clover is spreading everywhere; and the goldenrods and asters know no north nor south. While heartsease grows throughout nearly all North America the wild sunflower is confined chiefly to the West, cotton to the South, white clover to the East, and willow-herb to the North. Much narrower are the limits of many other species. The white-tupelo region is a tract of land along the Apalachicola River and the coast of South Carolina, Georgia, and Alabama; manchineel occurs in the extreme south of Florida; the black mangrove in tide-water marshes in the southern half of the same state. The palmettoes, white holly and the oranges are found in north central Florida. Our native acacias belong to Texas, the sages to southern California, and scores of other honey plants are equally restricted in their distribution. But it is not only in individual states that they are very variable in their range, but in almost every township; for example, within less than a mile of each other, yet without invading each other's territory, there may be found the salt-marsh goldenrod, the field goldenrod, and the wood goldenrod.

Honey plants are likewise very variable in the preference they exhibit for different soils. The tupelo and willows grow in wet swamps, the tickseed in marsh land, the smooth sumac prefers a rocky soil, the mesquite and cacti are dwellers in the desert; the gallberries in Georgia avoid a limestone region, while sweet clover will grow nowhere else. The spikeweed and the alkaliweed thrive in alkaline soil; the Rocky Mountain bee plant in a dry saline soil; the salt-marsh goldenrod in a soil and atmosphere impregnated with salt, while the fireweed springs up on burnt lands in the northern states and the production of nectar in wild alfalfa is greatly stimulated by a mountain fire.

Undoubtedly the secretion of nectar is often, if not always, correlated with the character of the soil, the temperature, and water supply. Alfalfa, which in irrigated sections of California is a large and most reliable yielder, is less important in the East, but is coming to the front very rapidly. A heavy thundershower followed by a sudden fall in the temperature may bring a successful honey flow from buckwheat or basswood to a premature end. Wild alfalfa may produce nectar abundantly on one side of the Coast Ranges, and very little on the other side. Heavy rains are likely to lessen greatly and light rains may either stimulate or retard the quantity of nectar secreted by a honey plant. The last honey obtained from lima beans and alfalfa is darker than the first. On a sandy soil the honey obtained from alfalfa is lighter in color than on a heavy soil, and lime in a soil is also reported to render a honey lighter. A prolonged drouth is apt to bring loss and disappointment, though it shortens the tubes of the red clover so that part of the nectar is available. Black sage requires a clear warm season preceded by abundant rain. Blue gum and red clover are very reliable yielders, and are largely independent of the weather.

Nor must the periodicity of honey plants be overlooked. The orange tree and the palmettoes in Florida can be depended upon almost every year. Orange is a reliable source in California. Sage does its best one year in five and is a partial failure every other year. The roles which govern the blooming of white clover have not yet been formulated. In many cases they are in flower for only a few weeks; but carpet grass yields from May until frost; pepper bush from July to September; pin clover in California begins in February and continues through the summer, and alfalfa from April to October. The different kinds of honey

vary also in the rapidity with which they granulate. (See Granulated Honey.)

Even where there is a good honey flora fair weather is essential, or the bees can not bring the nectar into the hive. The willows and the gallberries, which bloom in the spring when there is much rain and foggy weather, are, therefore, not so desirable as species which flower later. The succession of honey plants should also be considered. In California, after the orange trees have ceased to bloom, the bees if moved to the sages will get honey from that source if it is a season when they yield honey. After the sages comes the lima bean.

The Book, "Honey Plants of North America"

This subject of honey plants is covered fully in "Honey Plants of North America," a companion volume to this work. It contains, besides general information on sources of honey and honey localities, a complete list of plants that yield pollen and also a list of plants that yield nectar as well as pollen. No student of bee culture—certainly no one who carries on the business of honey production—can afford not to have the information imparted in this masterpiece by John H. Lovell, a botanist and biologist. His superb photographs show most of the important plants that have to do with bees. With these pictures, one without a knowledge of botany can pick out the plants that yield either pollen or nectar, or both, that he finds in his locality. It is important to know exactly what the bees are working on, in order to take advantage of the situation. For example, if one can know what his bees are working on, it may pay him to move his bees to a place a few miles away where the plant in question is more abundant. It is this exact knowledge that "Honey Plants of North America," can give which means dollars and cents to the beekeeper. For price and particulars regarding "Honey Plants of North America," write to the publishers of this work.

HONEY, SCIENCE OF.—The many books and articles which give scientific information on honey do not always give just what the beekeeper may wish to know.

Every beekeeper knows much about the granulation of honey. He knows that some honeys granulate soon after extraction, while others may remain liquid for months or years. He knows that some honeys granulate by the formation of fine crystals, while others are coarser. He knows that some honeys form a granulated mass at the bottom of the container, while others soon become solid. It is a natural inquiry to ask why these differences occur.

Contains Different Kinds of Sugars

Honey usually contains three sugars in varying proportions. Certain honeys contain only two, while others may at times contain certain exceedingly rare sugars; but for the present discussion the exceptional cases need not be touched upon. The usual three sugars are dextrose, levulose, and sucrose. The use of these chemical terms has a tendency to frighten many readers away from a discussion of the components of honey, but this is a needless fear. Every consumer of foods knows sucrose, for that is our ordinary cane or beet sugar, but the other two sugars are less well understood, although almost as commonly consumed by the general public. When cane or beet sugar is digested, it splits into two separate and unlike sugars and these are dextrose and levulose. When the beekeeper prepares sugar syrup from cane sugar for his bees for winter stores, he dissolves every crystal and then while the syrup is hot he adds a small amount of tartaric acid. He very soon sees that something has happened to the syrup, for, instead of the water-white condition of the original sugar syrup, a faint tint of amber soon appears. He also knows that if any of the syrup thus treated is not fed to bees but remains in the honey-house, it crystallizes in a manner unlike that of cane sugar and more nearly resembling honey granulation. These things indicate that some change has occurred in the syrup, due to the addition of the tartaric acid. This change is a partial splitting of the cane sugar into dextrose and levulose, so while these names of the sugars are not in common use, still beekeepers know well enough that something is in this syrup which was not there previously.

If a thick solution of cane sugar is allowed to cool and stand for a time, crystals are formed, this being speeded up if the syrup is dense. If syrups were made of dextrose and levulose of equal density, dextrose would crystallize out far more rapidly than does cane sugar, while in all probability the levulose would

remain in solution indefinitely. These facts indicate that the three sugars when in solution vary enormously in their propensities to form crystals. (See Science of Granulation under Granulation.)

What is dextrose? This sugar is exceedingly common in nature, being found in many plants and in all parts of these plants in greater or lesser amounts. It rarely if ever occurs singly, but in company with levulose, cane sugar (sucrose), or both. It may also by simple chemical means be manufactured artificially from any starch, a well known instance of artificial manufacture being the corn sugar, about which beekeepers are now so well informed. Corn sugar, as the manufacturers would have it called, might with great propriety be called starch sugar, since it can be and is manufactured from potatoes and other starches. The chemist also knows this sugar by the name glucose, but this word has been appropriated as a common name for a syrup made from corn and sold as glucose or commercial glucose so that this chemical name for dextrose now becomes confusing.

How Nature Manufactures Sugar

In the vital processes of the plant, when the rays of the sun fall on the green coloring material (chlorophyll) in leaves and other parts of plants, a chemical process is put under way. Carbon dioxide and water vapor, ordinarily difficult to combine, are united to form a carbohydrate. The word carbohydrate refers to this union of a carbon compound and water (hydrate). If later on this carbohydrate is burned or consumed in the plant or in some animal, the final products of the destructive process are again carbon dioxide and water vapor.

There is still some dispute as to what combination of carbon dioxide and water is first formed in the presence of chlorophyll, but at any rate there is almost at once formed a sugar, and this sugar is often dextrose. In order that the food material elaborated by the green parts of the plant from these raw materials may move about in the plant, the product formed must remain soluble in water, and during the time when food movement within the plant is necessary the sugar formed remains in the form of dextrose or some other relatively simple sugar. It may be moved to some part of the plant for storage, as in the tubers of the potato, where it is converted to an insoluble material, starch, to conserve space and to make the food less readily accessible, so in turn to save it for future use by the plant.

The sugar dextrose is a most interesting material. Now that it is artificially manufactured, probably many beekeepers have seen it under the trade name corn sugar. But every beekeeper has seen it many times before, perhaps without calling it by name. When honey first begins to form crystals, small crystalline particles may be seen suspended in the honey, giving it a cloudy appearance. These minute particles are crystals of dextrose. Once crystal formation is begun, it proceeds rapidly until soon the honey may become "solid." As a matter of fact, no honey granulates solid; for only the dextrose forms crystals, the remaining part being arranged as a thin film about the dextrose crystals. One may then use the word dextrose when writing for beekeepers with a firm assurance that it is a material which every one of them has seen many times, and about which they have a considerable start toward knowledge.

Why Granulation of Honey May Hasten Fermentation

When dextrose forms crystalline bodies each molecule of the sugar takes with itself one molecule of water from that used as a solvent. This water is equivalent in weight to just one-tenth of the sugar. This answers the question, "If one or more of the sugars in honey crystallizes, is the water content of the one remaining in solution modified?" Assuming that a honey contains 40 per cent dextrose and 20 per cent water, if the dextrose all forms solid crystals with the combined water, this leaves 16 per cent of the mass as water, or four-fifths of the original water. If then the remaining 40 per cent of solids or sugars is dissolved in four-fifths of the original water, the water content is increased over one-half, or the remaining sugar is in solution to the extent of 32 per cent water. This in turn answers the question, "Why is granulated honey more liable to ferment than liquid honey of the same density?" The reason is that the formation of dextrose crystals leaves more water with the remaining sugar, and fermentation is not only possible but far more probable than in liquid honey.

Some Chemical Terms Explained

In the terminology of the chemist, dextrose is an aldose hexose sugar. One often is inclined to criticize scientists for their use of technical terms, and it may be granted that it is silly and useless to use these terms unless there is a valid excuse. The word aldose, which we shall hereafter not find it necessary to use, refers simply to the peculiar arrangement of the atoms in the sugar molecule and this word to a chemist means a very definite thing. By using it, the chemist avoids a long description. The word hexose may be useful even to a beeman. It refers merely to the fact that the sugar molecule contains six atoms of carbon, the Greek root "hex" meaning six. If it will help to make this more understandable, one might use a hybrid word "sixose" instead, but such a word would cause a purist in languages to blush. The ending "ose," is merely a termination used for the names of all the sugars, as in dextrose, levulose, sucrose, and maltose.

The occurrence of six carbon atoms in dextrose places it in a class of sugars which become useful to many plants and animals. There are, for example, pentoses, or "five-oses," with five carbon atoms in the molecule, and these occur in many plants. Sugars of this class are entirely unavailable to a man as food, and the same thing is true of bees. Just what key unlocks the sugars with six atoms of carbon and fails to unlock those with five is still one of the mysteries of living things. There are also other sugars with seven, eight, and nine carbon atoms to the sugar molecule, these also being unavailable to man as food, but they have not been tested for bees. It does then, make a difference to the chemist to say that a sugar is a hexose, for it puts it in a separate and highly important class for him and for man and bees as food.

Dextrose is highly interesting in many ways. It is easily soluble in water, which all sugars are not but it also forms crystals, therein differing from other sugars. Levulose, for example, forms crystals only with difficulty. Dextrose also easily combines with itself to form other sugars. For example, malt sugar or maltose is formed from a union of two molecules of dextrose, forming a sugar of different sweetness, different taste, and different usefulness. Dextrose also combines under the influence of mysterious materials with other sugars to form still other complex sugars, such as cane sugar, about which more will be said later.

Relation Between Dextrose and Starch

The most interesting feature in the tendency of dextrose to unite with sugars is its ability to unite with other dextrose molecules to form highly complex units. Two molecules together make maltose, but when many more are combined we arrive at a group of complex compounds, with which, however, beekeepers and others are well familiar. A union of perhaps hundreds of dextrose molecules forms starch. Probably the starches of different plants differ in their complexity, and perhaps no starch from any one source has the same complexity at all times. At any rate, chemists are still undetermined as to the exact number of dextrose molecules which form various starches, knowing only that the number is great. Starch in turn breaks down to its original dextrose when it is to be put to use by plants or by animals which eat it, but the breaking-down is not one simple process. The complexity of the starch molecule is reduced by stages. The first series of products formed when starch is breaking down are the dextrins, substances of interest to beekeepers because when they occur in honey (and all honeys contain some) these dextrins are indigestible by bees, and dysentery may be caused. Dextrins are, therefore, merely steps in the breaking-down to soluble sugars, starch, as everybody knows, being insoluble in water.

Dextrose as a Food

Dextrose occurs in plants as such, in grapes and other plants, and for that reason is sometimes known as grape sugar. During the Napoleonic wars, when England put a rather effective barricade about France and cut off the supply of tropical cane sugar, the French were badly put to it for a sugar supply. Napoleon offered a liberal reward to any chemist who would devise a means of manufacturing sugar from grapes and it was at that time that the commercial manufacture of dextrose began. Later on it was found possible to make it from starches, and the latest development of this is the manufacture of corn sugar in this country.

Dextrose is an excellent food, easily assimilated, so that from the standpoint of

nutrition there is no objection to the sale and use of corn sugar. A dextrose similar in composition to that made from corn occurs in the blood and is therefore sometimes known as blood sugar. The objection of beekeepers to the two corn sugar bills was and is that sale without proper declaration would be a fraud, and it will always remain a fraud, even though it becomes by ill fate a legalized one.

Sugars Distinguished by Polarized Light

In the previous discussion on dextrose, mention was frequently made of the other sugar found in quantity in honey, namely, levulose. It may be well to discuss these two sugars for the purpose of contrasting them. The prefixes "dextr" and "levu," which precede the root "ose" (sugar) mean respectively right and left, and this introduces a most interesting fact regarding these sugars of honey.

Many years ago chemists discovered that if a beam of polarized light is passed through many organic solutions, the beam of light is turned from its original course to either the right or left. Ordinarily rays of light are energy waves emanating from the light source and vibrating equally in all directions, similar to radio waves, but of markedly different wave lengths and rapidity. If now a ray of sunlight is passed through a crystal of feldspar, it thereafter vibrates in one direction only instead of in all directions. If this ray of directed or polarized light is passed through a solution of sugar it no longer vibrates in the same plane as formerly, but the plane of vibration is turned to the right or to the left. The amount and direction of this turning is exceedingly valuable to the chemist in the determination of sugars present in a solution, since each one behaves differently in its effect on polarized light. As the names would indicate, dextrose rotates the polarized light to the right, while levulose rotates the plane of vibration to the left.

The explanation of this effect of the sugars on polarized light is most interesting. According to the chemist, both dextrose and levulose consist of exactly the same number of atoms of carbon, hydrogen, and oxygen, but these atoms are differently arranged in the two sugars. In both cases the arrangement of the atoms is not symmetrical, and the lack of symmetry is the cause of the turning of the polarized light ray. Taking the general arrangement which is thought to apply for dextrose, it may be calculated that there are in theory sixteen different possible arrangements of the atoms. Of these sixteen possible sugars of the dextrose group, only three, d-dextrose, d-galactose (a constituent of milk sugar) and d-mannose, are met with in nature, while skilled chemists have been able to devise in the laboratories eleven additional sugars of this group, leaving still two sugars of this group to be derived in the future.

The small letter "d" used as a prefix in the above names has a special significance, since there are eight sugars of the dextrose group for each of which there is a dextro and a levu form. There is, therefore, in theory a dextrose which rotates polarized light less to the right or more toward the left than ordinary dextrose of commerce, although both the *d-* and the *l-* forms are dexrorotatory, differing in this only in amount. Similarly there is a *d-* and an *l-*form of galactose and of mannose, and also of levulose, which belongs to another sugar group.

It is most interesting to note that of all the possible sugars capable of being derived from the basic arrangement of atoms in sugars of either the dextrose or the levulose group, only those having the prefix *d-* are utilizable as food by man or bees. It then appears that the arrangement of the molecule and the resulting effects on polarized light are matters of vital moment to man or animals in their utilization of these materials as food. It is a fortunate provision of nature that the unutilizable sugars are rare in nature or that some of them do not occur at all.

The Nature of Levulose

Levulose, or the constituent of honey which rotates polarized light to the left, is a sugar of great interest and value. It occurs in nature in the juices of plants and fruits in company with dextrose. It occurs alone in chicory and especially in the Jerusalem artichoke. It is a highly nutritious sugar and the sweetest of all the known sugars found in nature. To calculate the relative sweetness of the various sugars is not an easy task, and as a result there is considerable variation in the estimates of the sweetness of levulose as compared with cane sugar, the estimates varying from 103 to 173 per cent. Certainly the estimate of 103 per cent is wholly wrong, as will be attested by any one who has ever tasted

this delicious sugar, and the higher estimate is probably about right. Dextrose, on the contrary, is about half as sweet as cane sugar and therefore less than a third as sweet as levulose. There is present in honey usually slightly more levulose than dextrose, which accounts for the greater sweetness of honey than of cane sugar.

Levulose does not easily form crystals, and it is the relatively high levulose content of honey which retards granulation or crystallization, in some cases for months or years. The artificial manufacture of levulose in a chemically pure state has been an exceedingly difficult problem for the chemist, as is shown by the fact that chemically pure levulose now sells at several dollars a pound. In 1926 the Bureau of Standards published a method devised in that organization for causing the formation of levulose crystals from a water solution, and if this works out properly under commercial conditions there is a possibility that levulose may become cheaper. That it will become cheap enough to compete with dextrose, cane sugar, or honey on the market is highly improbable, according to the general opinions of chemists.

Just as dextrose is stored in concentrated form in plants as starch, so levulose is stored in the Jerusalem artichoke, dahlia, chicory, burdock, goldenrod, and dandelion as inulin. When inulin splits to simple sugar, it yields only levulose. In view of the fact that a material for the treatment for diabetics has been discovered in the form of insulin, care must be exercised not to confuse inulin and insulin, for they are not related. The Jerusalem artichoke does not indicate a geographical origin for this plant, but Jerusalem in this case is a corruption of the French for this plant, *girasole*. It is, in fact, not a true artichoke at all.

Levulose in the Diet

Levulose has some interesting features from the standpoint of diet. It is tolerated by diabetics more readily than are either dextrose or cane sugar, yet levulose as such is rarely found in the blood. By some mysterious process, as it passes through the walls of the alimentary canal, levulose seems to be transformed into dextrose, the sugar of the blood. Dextrose and levulose in the diet are, however, not of equal value in bodily processes, since dextrose is thought to be more important in respiratory processes and levulose more important in the elaboration of tissues.

Levulose is a less stable sugar than dextrose and this is shown in several ways more or less familiar to the beekeeper. For example, when invert sugar (a mixture of dextrose and levulose in equal parts) is made by heating cane sugar in the presence of water and an acid as in making winter food for bees, there is a tendency for the former clear solution to become somewhat amber in color. This slight coloration is due to the breaking-down of minute amounts of levulose under the influence of a boiling temperature. Not many beekeepers have kept samples of honeys for many years, but those who have kept it have noticed that after a time the honey takes on an appreciably darker color. I was once presented with a sample of California sage honey thirty years old which had originally been the lightest of water-white honey, but when received it was a deep wine red and clear as crystal. Another sample of white clover honey about forty years old was stll darker. Samples of California sage honey ten years old had darkened appreciably and granulation had begun. This change of color is due to a slight breaking of the levulose in the honey, due possibly in part to the action of light.

It is interesting to note that while California white sage honey, water-white in color, rarely granulates under ordinary circumstances, yet when it has aged and has lost some of its levulose by this breaking-down process, granulating begins. In the sample of sage honey thirty years old, exceedingly large crystals had formed to fill the container about one-third of the way up, these large crystals being formed by exceedingly slow formation of crystals, as explained earlier. In the sample ten years old, the crystals were still minute and were scattered throughout the honey as a slight cloudiness. White clover honey granulates more freely than does pure sage honey, and the sample forty years old was perhaps three-fourths filled with large crystals. Nobody knows how many times granulation had advanced and retreated in this sample with changes of temperature during the summers and winters that this sample had been kept, but probably the granulation

increased with each drop of temperature and decreased again each summer.

Levulose is, then, the sugar which ordinarily does not granulate in honey, and an unusual amount of it in any honey may prevent granulation, as in sage and tupelo honeys. It adds greatly to the sweetness and desirability of honey with regard to taste. The characteristic flavors of honey are derived from more complex materials found in most minute quantities in honey, yet the presence of levulose doubtless adds appreciably to the delightful flavors and tastes of our product.

What Happens When Nectar Is Changed Into Honey

Dextrose and levulose combine in plants to form cane or beet sugar (sucrose.) Sucrose occurs in small quantities in most honeys, although some honeys are free of this sugar and the amount tolerated under the administration of the Federal Food and Drugs Act is not to exceed eight per cent. The formula for sucrose is not exactly twice as great as that of the two constituent sugars, since one molecule of water is eliminated in the combination. Conversely, when cane sugar is reconverted to dextrose and levulose in the ripening process of honey, one molecule of water is taken into the combination. The conversion of cane sugar to dextrose and levulose assists the bees in the elimination of water to some extent, by utilizing one molecule of water for each molecule of cane sugar changed to the simple sugars. This amounts to only ten per cent by weight of the amount of cane sugar found in the nectar, which does not greatly reduce the work of the bees in water elimination from nectar. However, in the making of invert sugar syrup for the bees in winter, if we start with a two-thirds solution of cane sugar and if inversion is completed, this process alone decreases the water content to about 28 per cent, instead of the original 33 per cent. As a matter of fact, inversion is not completed in the ordinary process of making a winter food by the use of tartaric acid in a heavy solution of cane sugar.

When cane sugar is converted to dextrose and levulose these two simple sugars are present in exactly equal amounts, and since these two sugars do not, as a rule, exist in honeys in exactly equal amounts, this suggests that levulose as such is present in the original nectar. Dextrose is also usually present as such in nectars, according to available analyses. The change of sucrose to dextrose and levulose occurs in the alimentary canal of the bees as well as in that of man. This transformation is a relatively simple one and does not place much of a burden on the normal digestive system. There are, however, persons who find this transformation difficult at times. A certain time is necessary for this change to take place, which is in itself of some importance, since a delay in the digestion of cane sugar may permit fermentation to be set up. Fermentation is more apt to occur in the human stomach from the eating of cane sugar, because of the fact that the sugars of honey are immediately ready to be absorbed and there is no delay.

There are still other sugars sometimes found in honey as well as more complex carbohydrate compounds about which more will be said under Vitamins and Yeasts in Honey.

In discussing the sugars of honey we are engaged in a romantic aspect of beekeeping, a phase of the subject well worth consideration, even though there still remains much more to be studied. The whole subject of the carbohydrates and their relation to human and bee diet is entrancing even though at times complex, and it is worth the while of every beekeeper to read and to study this phase of his subject. Beekeeping is something more than putting on supers and extracting honey. Part of the job is to sell the product, and at present this is the hardest part of the beekeeper's work. Some gain may be made if and when beekeepers and their customers know more of the thrilling mysteries of this product.

HONEY SENSITIZATION.—The most common ill effects from eating honey, disregarding those of simple gluttony, are cramps, heartburn, gastric indigestion, and indefinite general discomforts immediately following partaking. These unfortunate individuals are afflicted with what is known as honey sensitization, or honey allergy.

A sensitive or sensitized person is one who is adversely affected by very small quantities of nitrogen-containing substances which do not so affect other individuals. Allergy is a broad term covering

sensitization in all of its manifestations. Commonly recognized allergies are: pollens causing hay fever, and various dusts or animal emanations inducing asthmatic attacks. Foods are allergic to some persons and when injected cause similar local conditions in the alimentary canal.

Babies are much more susceptible tc food allergies than grown-ups. This must be remembered in modifying baby's milk with honey.

Ingredient Which Causes the Distress

Sensitiveness to honey is one of the least common of food allergies. Eggs, for instance, affect hundreds to one adversely affected by honey. The exact reason for honey being abnormally irritating to some is much disputed. Some claim that it is because of the few suspended pollen grains or because of extractives from the pollen coming in contact with the honey while in the comb or in the extraction process. Others claim that the sensitization cause is the aroma incorporated in the honey as a most essential part of the flavor. Some say it is the osmotic action. See page 398.

Occasionally the offender is the comb and not the honey at all. I personally encountered one such case, a person who could eat extracted honey but not comb honey. Also I encountered one person sensitive to Illinois honey but who could eat Puget Sound honey with impunity.

Influence of Heredity

The tendency to become food sensitive is hereditary. The substance causing illness may vary among different members of the family. One family tree showed a child sensitive to mutton, in other words, mutton always made him sick. The father was sensitive to nuts, particularly walnuts. He liked walnuts but they made his tongue sore and caused intestinal indigestion. The grandmother liked honey, but it caused gastric cramps and acute indigestion. The great grandfather was sensitive to mutton. Here were two generations not sensitive to mutton but sensitive to other foodstuffs between the two mutton-sensitive individuals. Only one member of the entire family tree was honey sensitive.

Just why should this grandmother be unable to take honey? Why she should have such severe cramps and acute indigestion when eating honey was a great problem until food allergy was learned of, and that family tree studied. All individuals of the family were of long life and healthy in all ways except for a marked tendency to digestive disturbances. This was usually limited to certain foods. Seemingly no two had the same dislikes. That merely showed that the tendency to become food reactive was hereditary. Special sensitizations are not hereditary. Among approximately forty individuals studied in this family, only one was honey sensitive.

Some honeys are naturally disagreeable to all persons. This is because of the plants furnishing the nectar. I once obtained a sample of dark, bitterish, supposedly-cascara honey that had the laxative effect of cascara. Rhododendron honey is supposed to be generally toxic, although what I sampled as such was not. Both of these small trees grows abundantly in localities about the Puget Sound country. Some day there are going to be human ailments traced authentically to bad honey. That will be real undesirable publicity.

Sensitization is Really a Life Saver

Being sensitive to foods, animal emanations, dusts, etc., sounds like something is decidedly wrong in natural economy. It is not, but is one of the necessities for protection of life. It is this sensitization ability that enables the body to overcome disease. It is the body becoming sensitized to bacterial poisons that causes the fever and initials the development of antitoxins and immunity. Those deficient in ability to become sensitized often become carriers and chronic sufferers. You have all heard of diptheria carriers and of typhoid carriers, who, while carrying the germs, are not ill themselves. Were they sensitized they would react and throw off the infection.

The Remedy

The ordinary remedy for food sensitization is to leave that food alone for a time, hoping that the sensitiveness will wear off. Quite commonly it does. I suggest that a honey sensitive person leave honey alone for from two to six months, then try the extracted from some locality with an entirely different flora; if this causes no disagreeable symptoms, try honey in comb. It is a case of try a little at a time, one of trial and error. Foods including honey, like alcohol, affect no two exactly the same.—W. Ray Jones, M. D., Seattle, Washington, in Gleanings in Bee Culture, page 462, for 1933.

HONEY, SPECIFIC GRAVITY OF.—Ordinary well-ripened honey, when ready for the market, should run slightly under 12 pounds to the gallon at from 72 to 74 degrees temperature, which would mean a specific gravity of from 1.40 to 1.45, or, on the Baumé scale, from 41 to 43. It should, however, be noted that a gallon can that will hold exactly 12 pounds of ripe honey at normal temperatures, will hold only 11 pounds, 9 ounces when that honey is heated to 160 degrees to prevent granulation. When, however, this honey cools, 7 ounces more of cold honey can be added, but as a rule most gallon cans of honey contain that amount less than the 12 pounds, and should be so labeled to conform to state and federal laws. Honey from arid regions of the West are slightly thicker than the average honey in the East.

There are some honeys that run only 11½ pounds to the gallon. There is danger that these honeys are not fully ripened and may ferment. (See Honey Spoilage, opposite.) Thin, watery or unripe honey should be stored in open cans in a dry room for a few weeks, so that the excess moisture can escape. Honey exposed in a damp atmosphere will take on more moisture. It is, therefore, important that the artificial ripening process take place in a warm dry room, heated artificially if necessary. As a rule, it is not wise to extract honey in the eastern states unless three-fourths of all the cells are capped over; and sometimes then the honey should be left on the hive until all the cells are sealed. In the western states, where there is a drier atmosphere, or during extremely hot dry weather in the East, a larger percentage of unsealed cells may be permissible at the time the combs are extracted; but it is best to store in open cans for a short time before shipping. (See Extracting.)

When honey is not thoroughly ripened the thinner portion is apt to rise to the top while the heavier part will settle to the bottom. (See Nectar.) The top will have a tendency to sour, and it will not be long before the whole mass will be involved. If the souring or fermenting process has not gone too far, the honey may be saved by heating, thus destroying the yeast plant. But if it has gone too far, nothing can be done but to convert it into vinegar. (See Yeasts in Honey, Honey, Science of, and Vinegar.)

HONEY, SPOILAGE OF.—It is generally held by many beekeepers, and others as well, that honey will keep indefinitely, and recent investigations show that it is actually possible to keep honey in its natural condition over a long period of time if stored at temperatures below 50° F. However, because of the ease with which honey is broken down at higher temperatures, it may be thought of as a product readily perishable under average conditions, and those who have had the opportunity to study numerous samples of honey know that it rapidly deteriorates in color and flavor at relatively high temperatures, and, when contaminated with yeasts, it spoils from fermentation at relatively low temperatures.

Honey that is one year old is generally considered by bottlers and brokers to be inferior to freshly extracted honey. Furthermore, the bottlers are suspicious of any honey that they buy after the first of January because of the possible danger of fermentation. This fear on the part of bottlers or dealers is well founded, but the reasons have not been demonstrated until in recent years.

Many beekeepers are unaware that there are good and bad methods of storing honey after it has been extracted. However, we now know on the basis of observations and experiments that temperature is of the utmost importance when honey is held in storage over long periods of time. We have samples that have now been in storage for nearly four years. Up to the present time, they show no signs of deterioration, either from fermentation, loss in flavor, or change in color.

There are three general conditions to be found in the deterioration of honey, any one of which is sufficient to lower the market grade of the product. In order of importance these are: spoilage by fermentation, loss of flavor, and color changes in which the color passes from a lighter to a darker grade. The proper handling of honey after its removal from the beehive and during its progress to the consumer is a very important problem.

If honey is not well ripened or if it is allowed to absorb moisture while stored in open tanks, fermentation is sure to occur when temperature conditions are favorable for the development of yeasts in honey. Even supposedly well-ripened honey is subject to fermentation as a result

of the physical changes that occur during granulation after the honey is extracted and put in cans or jars. Most honeys contain a high content of dextrose and crystallize soon after being extracted from the comb. The crystallization of the mass is not complete, however, for close examination will show that the crystals are dispersed in a dilute liquid phase. (See Bottling and Granulation of Honey.)

Yeasts in Honey

Fermentation in honey is caused by yeasts, and a half dozen or more species have been discovered and described by scientists. Yeasts are found everywhere, and sugar tolerant yeasts which are capable of fermenting honey occur more or less abundantly in and about all bee yards as shown by a number of investigators. Spores of these yeasts are to be found in practically every sample of honey, and fermentation is almost sure to occur in all honeys after complete crystallization if held for a long period of time at temperatures suitable for the development of yeasts. (See Yeasts in Honey.)

The Relation of Moisture to Fermentation in Honey

Moisture is necessary for fermentation. Beekeepers have for a long time known that excess moisture has some relation to the spoilage of honey by fermentation, but without knowing just how it came about and more particularly the combined relation of moisture and temperature.

It is known that honey extracted in the season from unsealed combs is more likely to ferment than honey from fully sealed combs or from even partially sealed combs extracted late in the season. Honey from fully sealed combs is generally considered ripe honey by the beekeeper, but many of them believe that the maturing process in honey continues after the combs are sealed if they are left on the bees. For this reason, many beekeepers do not remove the honey from the hive until a month or more after it is fully sealed.

The moisture content of honey extracted before combs are partially sealed is undoubtedly higher than honey from fully sealed combs. But honey absorbs and gives off moisture equally well under proper conditions. Even honey that is extracted early in the season will give off moisture and become thicker in a dry atmosphere, and honey will absorb moisture and become thinner in a wet atmosphere. It is, therefore, difficult to decide when honey is safe from fermentation, but in the humid climates of eastern United States, honey should not be extracted until the combs are at least two-thirds sealed.

Because of the fact that fermentation begins at the top of a container and works downward, and also because it has been shown that there is more moisture in the top layers of crystallized honey than in the bottom layers, it is quite evident that moisture does play an important part, but temperature is equally important and probably really governs fermentation. Honey containing a high percentage of moisture does not ferment at temperatures below 50° F., and only slowly or not at all at temperatures somewhat about 80° F. Honey of relatively low moisture content will nearly always ferment if held for any period of time at temperatures near 60° F.

The Relation of Temperature to the Spoilage of Honey

Experimental evidence is now available to show that temperature has an important part in the preservation and spoilage of honey after it is removed from the hive. At the Wisconsin Agricultural Experiment Station a wide range of samples has been taken at weekly periods during the honey crop seasons of 1929, 1930, 1931 and 1932 and placed in chambers fitted with devices for keeping the temperature constant for long periods of time. The samples of honey in glass jars have been held for long periods of time in these chambers at temperatures of 40° F., 60° F., 64° F., 75° F., 80° F. and 100° F.

The information secured from these experiments shows that any lot of honey is continuously affected by the temperature conditions surrounding it while on its way to market. Below a point of about 50° F. to 55° F. no changes take place, and honey may be preserved in its natural state for a long period of time. At 60° F. honey ferments more quickly than at higher temperatures. Honey crystallizes more rapidly with the lowering of the temperature, and since most honeys must become crystallized before fermentation begins there is a temperature at which, with rapid crystallization, fermentation develops more rapidly than it does at other temperatures. With our present knowledge of the subject this temperature

appears to be near 60° F. Above this point fermentation is delayed by slower crystallization. Fermentation in crystallized honey is also slow to develop at high temperatures, and at 75° F. honey may be kept for two or more years without noticeable changes in color or flavor.

At 80° F. normal honey in sealed containers have not fermented during a period of nearly four years, but serious deterioration in color and flavor takes place after sixteen months so that if honey is allowed to remain at temperatures above 80° F. for a long period of time no fermentation is likely to occur, but detrimental changes in color and flavor are sure to occur. (See Extracted Honey, subhead, How to Keep Extracted Honey, on page 250.)

As the storage temperatures increase above 80° F., deterioration in color and flavor increases. With this knowledge beekeepers can often prevent losses from fermentation as well as from changes in color and flavor by using care in selecting storage rooms for their honey. Of course, the easiest way to prevent fermentation is to heat the honey to 160° F., then immediately put it into sealed containers. If this is done carefully, honey will not ferment regardless of where it is stored. Many beekeepers follow the practice of heating their honey before putting it in cans for market, but there still are many who do not, and every year losses occur from fermentation which could have been avoided. Losses due to changes in color and flavor are continually greater than necessary.

One important fact in the whole marketing situation is that the beekeeper should not be held responsible for losses by fermentation, provided the shipment was in good condition when shipped. Dealers buying carload lots of honey should be made acquainted with the danger of holding unheated honey for any length of time in storage rooms when the temperature is from 55° to 65° F. Beekeepers who do not heat honey before canning should not store it in cool basements and should not leave tanks of crystallized honey open where moisture can be absorbed. The danger of fermentation is too great.

Honey extracted from unsealed combs during the first two weeks of the honey flow should not be sold unless heated to 160° F. When unheated honey is sold in 5, 10, or 60 pound tins the customer should be warned not to store honey in the basement if the temperature is lower than 70° F.

HONEY, SWEETNESS OF.—Authorities differ somewhat regarding the relative sweetness of honey and other sugars. Of the two principal sugars in honey, levulose and dextrose, it is generally agreed that the former is sweeter than cane sugar and that the latter is less sweet. Putting cane or beet sugar at 100, Browne, assistant chief of the United States Bureau of Chemistry and Soils, rates dextrose at 50 and levulose at 175. Others put dextrose at about 70. In either case honey would be sweeter than cane sugar. With cane sugar standing at 100, honey would be 112½ or 122½.

Lucas puts honey as low as 57, but admits that Tracy may be nearer right when he places the figure at 75. (See Honey Ice Cream.) Some rate honey as sweet as cane sugar less 17 per cent for the water content. This would put honey at 83.

Ice cream makers usually say that honey is sweeter than cane sugar because an all-honey cream is too sweet and must be reduced with another sugar. It seems to be generally agreed that an ice cream in which honey is the only sweetening agent is too rich or too sweet and that it is necessary to tone it down with a sugar less sweet, like corn or cane sugar. The same principle applies to candy. A strict honey candy is too sweet and hence it must be toned down with milk or corn sugar (dextrose) or milk powder or even skim milk powder. Either of these are dried milk and differ from milk sugar (lactose) which is only a part of the original milk. (See Honey Candy.)

Prof. H. A. Schuette, Department of Chemistry, University of Wisconsin, speaking of the sweetness of honey, says:

> Everybody knows that honey is sweeter than sugar. But why this is true is perhaps not such general knowledge. Here is the answer: as I stated before, the predominating sugars in honey are dextrose and levulose. There is also usually a small, but far lesser amount of ordinary sugar, or sucrose. Levulose is relatively much sweeter than sucrose, but dextrose is not as sweet. In the first case the ratio is approximately 17 to 10, in the latter it is 7 to 10. Since honey consists, in a sense, of an equal mixture of those sugars, it follows that the greater sweetness of the levulose is somewhat reduced by that of the less sweet dextrose, yet the average of the two is above 100—the figure arbitrarily chosen for our yardstick, or ordinary sugar.

In the Scientific Monthly for January, 1928, appears an article by Dr. J. J.

Willaman of the University of Minnesota, discussing the relative sweetness of different sugars. It is a little difficult, he says. to measure the sweetness of sugars by any means. Perhaps the most reliable, certainly the one that decides the sweetness of any sugar, is the one of taste.

In order to eliminate the possibility of error, a series of solutions of a given sugar in distilled water were prepared, ranging in concentration from one markedly sweet to one not perceptibly sweet. A subject, usually a woman, was seated, blinded-folded, and given a sip of distilled water. Then the tip of her tongue was swabbed with cotton, and a drop of one of the solutions was placed on the tongue. Immediately the patient would say "Yes" or "No" or "Doubtful." By skipping around among the solutions, and recording the decisions, a very good idea was obtained as to the weakest solutions of that sugar that could be tasted. And by using 15 or 20 people on each sugar the accuracy was greatly increased. From the threshold values were calculated the relative ratings listed in the table.

RELATIVE SWEETNESS OF CERTAIN SUGARS

Fructose	173
Invert Sugar	123
Sucrose	100
Glucose (dextrose)	74
Xylose	40
Maltose	32
Rahmnose	32
Galactose	32
Raffnose	23
Lactose	16

By referring to the table it will be noticed that invert sugar is much sweeter than even cane sugar. Under the head of "invert sugar" comes honey. As honey contains a greater proportion of levulose than ordinary artificial invert sugar, it will be seen that honey is even sweeter than invert sugar. Levulose and fructose are one and the same thing. (See table.) All honeys contain more levulose than dextrose, and this is the reason why a little honey will go a long way because it will be noticed that levulose is nearly twice as sweet as cane sugar.

We beekeepers have the argument that honey is not only a nutritious sweet, but even at an advanced price over cane sugar it is relatively cheap. Add its flavor, protein, and mineral elements, and the combination is an ideal health sweet, the only concentrated sugar food in nature.

Dr. Willaman's work agrees substantially with that done by Browne of the Bureau of Chemistry and Soils. It is closely in accord with the experience of the ice cream and candy makers who do not want a product too sweet.

In conclusion it is pertinent to add that while honey will cost more than granulated sugar it is probably sweeter and goes further pound for pound. It certainly has flavor and this added to its sweetness makes it go a long way in other foods. Honey is so sweet that it must be eaten with other foods like bread, hot biscuits or hot cakes to be enjoyed. (See Honey in Cooking and Baking.)

HOUSE-APIARY.—See Apiary.

HUAJILLA (often spelled guajilla) pronounced wauhéa (*Acacia Berlandieri*).—In the semi-arid region of the Rio Grande Plain in Texas, mesquite, white brush, prickly pear, Texas ebony, catsclaw, re-

Huajilla.

tama, and huajilla are abundant and yield a large surplus of honey. The three main honey plants are mesquite, catsclaw, and huajilla, but huajilla is the most im-

portant of the three. Huajilla occupies the rocky ridges and hills in the northern part of the section extending from the Nueces River to the Rio Grande. It has small yellow flowers in globular clusters. It blooms in April and yields nectar for about 15 days in such abundance that it is impossible for the bees to gather it in favorable seasons. The honey is white, or sometimes almost water-white, or a very light amber, and is probably the lightest colored honey produced in the state. It has a very mild flavor and is famous for its excellent quality and pleasing aroma. It granulates early with a coarser grain than catsclaw honey. The flow is not reliable every year. Huajilla honey unmixed in commercial quantities is difficult to get, as this species and catsclaw usually bloom at the same time. For further particulars see "Honey Plants of North America."

HUBAM.—See Sweet Clover, White Annual.

HUMBLEBEES.—See Bumblebees.

HYBRIDS.—A hybrid may be a cross between species or between varieties of a species. Bees mentioned under this head belong to the class last mentioned—a cross between varieties, and usually between Italian and common black bees. One who has had Italians very long probably knows that hybrids (a cross between Italians and common black bees) are cross, especially if he had kept bees when the honey crop was very suddenly cut short. They are very much crosser than pure Italians or blacks. Many of the old veterans in the business have concluded, even though the hybrids will secure as much honey, and sometimes even more, that it pays to Italianize. A good strain of leather-colored Italians* will be almost as gentle as flies, and will gather fully as much honey as hybrids. Generally the half-bloods can be handled, when weather conditions are right, nearly as easily as Italians; but as a rule they require more time in that the operator must proceed much more cautiously in order not to excite them.

While hybrids are not as hard to handle as pure Cyprian, Holy Land and Giant bees, they are bad enough. The fact that hybrid queens, if sold at all, bring only about one-fourth the price of pure Italians gives one some idea of their relative value in the open market.

But the most serious objection to hybrids and blacks is the fact that they are an easy prey to the ravages of European foulbrood (see Foulbrood, subhead, "European Foulbrood"). While hybrids are more immune than the blacks, the average pure Italians seem to be able to resist the disease much better than the average crosses. In some parts of the country the hybrids and the blacks are dying off for the simple reason that they can not stand the ravages of European foulbrood as do the Italians.

In many large apiaries throughout the country hybrids are tolerated simply because their owners do not take the time to Italianize. Where one owns a series of outyards, comprising from 500 to 1000 colonies, it would be rather expensive to buy Italian queens; but if he will follow directions given under Queen-rearing in this work he can rear his own queens; and this brings up the question whether the blacks and the hybrids in a locality will not make it impossible to rear pure stock. If one will use drone-traps on all colonies where there are black or hybrid drones, and then insert a drone comb in the center of the brood-nest of the best Italian colonies, he will soon have a great preponderance of pure Italian drones. The result will be that the most of the young virgins will meet drones of their own race. (See Drones; also Queen-rearing.)

Another plan to insure pure mating, is to wait till after the main honey flow, when all colonies, unless fed, will kill off their drones. If two or three colonies, having select or pure drones, are fed a little every day, these drones will be kept while all others will be killed. If a batch of pure Italian virgins of mating age are let loose at this time, they will meet only the select drones of the fed colonies. In this way pure matings can be secured even where hybrid and black colonies greatly predominate. It is important, however, to feed the colonies of select drones a little every day if not queenless, until all the queens are mated. If even one day is skipped, the drones will be killed off.

Hybrids of Carniolans and Caucasians with Italians

In this country, at least, very little has been done to determine with accuracy the

*For a test as to what constitutes a hybrid, see Italian Bees.

value of different crosses which can be made very easily. A cross between Italians and Caucasians has been spoken of very favorably by J. J. Wilder, of Waycross, Ga., at one time the most extensive beekeeper in the country. Mr. Wilder says this cross will rear brood under conditions and at seasons of the year when pure Italians will do practically nothing. In some parts of the South it is very desirable to have a strain that will rear brood in and out of season, because of the succession of honey flows that may occur. Pure Italian stock has a tendency to stop brood-rearing almost entirely after the main honey flow. If there be another honey flow two or three weeks later, without brood-rearing in the meantime, the force of bees will be greatly reduced, and bees that are left will be of little value.

In the same way a cross between Carniolans and Italians has been found to be equally profitable.

Other hybrids may be considered by the beekeeper who wishes to produce a superior strain of bees for some particular purpose. It is well known that crossing, as a rule, increases the size, courage, and stamina of our domestic animals, and this is probably true of bees; yet beekeepers have made but little progress along this line, because it is so difficult to distinguish between the crosses and pure breeds in many cases. (See experiments of Newell, under Dzierzon Theory, subhead Recent Evidence in Proof of Dzierzon Theory; also Drones and Parthenogenesis.)

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INCREASE.—See Dividing and Nucleus.

INSPECTORS. — Under the head of Laws Relating to Foulbrood will be found references to bee inspectors, who, clothed with the authority of the state, are to discover and eradicate bee diseases. Under this head an attempt will be made to give the qualifications of a bee inspector. First of all, he should be an experienced beekeeper; second, he should have a theoretical and practical knowledge of all bee diseases, particularly those relating to brood; third, he should be intelligent, broad-minded, and tactful.

Taking up the first requirement, a bee inspector will be very seriously handicapped if he does not have both a theoretical and a practical knowledge of bees. One of the most important factors in the elimination of disease is the instruction given the beekeeper in the first place on how to keep bees, on the principle that prevention is better than cure. The inspector should explain the normal conditions in a hive so that the owner of the bees will be able to recognize at once those that are irregular and abnormal. A large number of those who keep bees have but little knowledge of the business. In many cases, swarms alighted on the premises and were hived. In other cases the bees were bought at auction because they were cheap; in still others, some of the family may have gotten the bee fever, and, after building up the apiary to four or five colonies, left home. The rest of the family have but little or no interest in the bees, but are glad to get the honey if there is any. These little yards of bees, no matter how acquired, are left to shift for themselves, and the result is they afford favorable places for the attack of bee disease. Their owners are not apt to read bee books, but will receive personally any amount of instruction on how to take care of them. A good bee inspector, one who thoroughly understands his job, can be the indirect means of putting in nice condition all these little apiaries that would otherwise be neglected. The owners will be getting a revenue; and if bee disease does make a start they will be able to arrest it in time.

The second requirement implies a theoretical and practical knowledge of bee diseases. If the owner of the bees discovers that a man sent out by the state

does not thoroughly know disease when he sees it, the inspector is under a handicap. If the beekeeper himself is a practical man, he will probably do just as he pleases, thinking he knows more than the representative of the state. As a general rule, the bee inspectors are thoroughly informed in regard to bee diseases before they are sent out.

The third requirement is sometimes hard to meet. It is not difficult to get a man who understands bees and bee diseases; but it is not so easy to add to those qualites the third one—intelligence and tactfulness. An inspector who goes out on tours of inspection meets all kinds of people. He should be able to size up his man at a glance. If he should approach the beekeeper and say, "I am the state inspector, and I require to see your bees," he might meet with some opposition; but if, on the other hand, he approaches his man with smiles and a handshake, and asks him if he has any bees, and how they are doing, he will usually meet with a pleasant response. The inspector can then say that he is sent by the state to give instructions on how to keep bees, and that if he can be of any help he is at their service, etc. Then the beekeeper will be interested. Mr. Inspector can very gracefully volunteer the statement that there is considerable bee disease in the country, and if any is present in the hives he will be glad to tell what to do. If he is tactful he will not put forth any show of "authority" nor invade the premises without finding some member of the family. If the owner is not present he can ask permission from some one in the house to see the bees, explaining the matter in a tactful way. Usually the good housewife is perfectly willing to tell him where the bees are.

Inspectors—Who Can Qualify?

Students from apicultural schools that are scattered over various parts of the country can usually be secured for a very moderate sum. These men, after having taken an apicultural and agricultural course, have a theoretical and practical knowledge of general farm problems, such as soil, fertilizers, fruit-growing, and the like. When it is not possible to use an inspector in the line of beework, his talent can be turned to very profitable account along other agricultural lines. It is desirable to have a bee inspector who not only understands bee culture but agriculture in general.

The nursery inspectors who are sent out over the country are rendering excellent aid by telling farmers how to handle their fruit trees in order to keep down blight, San Jose scale, and, in general, how to secure a large amount of fruit. These men are rendering their respective states most valuable service, because there is nothing like a practical demonstration in the orchard of how to treat the trees and how to trim them so as to secure the maximum results. This kind of actual field demonstration work is invaluable, not only in orchard work but in actual beekeeping. If possible, a bee inspector should be one who understands both orchard and bee work, as they naturally go hand in hand. (See Fruit Blossoms.)

Under the head of Laws Relating to Foulbrood, it will be seen that the better plan is for the inspector to keep in the background all show of authority and law, and put emphasis on general extension work. For other particulars see Laws Relating to Foulbrood.

INTRODUCING.—The success or failure in introducing depends very largely upon the size of the colony and the temper of it. A weak colony or nucleus will accept a strange queen when a strong one will not. Again, when there is a dearth of honey, or weather is chilly, introducing is much more difficult than when the weather is favorable and honey is coming in.

Under normal conditions only one queen will be tolerated in a colony at a time. Should there by accident be two, there will probably be a royal battle, when they meet, until one of them is killed. Queens are, as a rule, jealous rivals; but there are exceptions. Under certain conditions, as when an old queen is about to be superseded, the young daughter may be tolerated in the hive along with her mother—both laying side by side; but in the course of a few days or weeks the mother will be missing. Whether she dies of old age or the daughter kills her is not known. There are other conditions where two and sometimes a dozen virgin queens will be found in the hive, but under circumstances which seem to be abnormal.

Again, it may be stated that a normal colony of bees will not readily accept a

strange queen, even though they have no mother of their own, much less will they accept an interloper, when there is already a queen in the hive. It may, therefore, be set down as a rule that has exceptions,* that it is not safe to liberate any queen, young or old, in a colony that already has one. Likewise, bees that are queenless will not under ordinary conditions, accept another, no matter how much they need one, until she has been "introduced." There are exceptions to this also. A colony long queenless, if there are no laying workers, will sometimes accept a new mother without caging. It follows that, in the process of requeening, the apiarist is compelled to put a new queen in a wire-cloth cage and confine her there (where the other bees can not attack her) until she has acquired the same colony odor or individual scent as the bees themselves. This takes three to six days, at the end of which time the queen may be released, when the bees will treat her as their own royal mother. It is not known how bees recognize each other, or how they can tell a strange queen from their own, except by the scent factor.

It is a fact well recognized that a dog can pick out his master from hundreds of others through the agency of scent. He can also track his master, if he loses sight of him, by catching the scent where he has walked, in spite of the fact that hundreds of other people may have gone over the same ground. This scent that is so acute in a dog is undoubtedly highly developed in the bee, otherwise it would be difficult to account for some of the phenomena in the domestic economy of the hive. (See Odor of Laying Queens, under Queens.)

From what has been stated it is natural to conclude that, by the sense of smell, bees distinguish their own queen from a new or strange one.

Again, it is learned that, if two queens have exactly the same colony odor after being caged for two or three days in a queenless hive, either one may be liberated, and the bees will accept one just as readily as the other. If both be liberated at the same time, one in one corner of the hive and the other in the opposite corner, both will be tolerated by the bees; but once the queens come together themselves there is danger of a royal battle* resulting in the death of one. From this fact it is inferred that the bees, provided a queen or queens have the requisite colony odor, will accept at any time one or more such queens; that, further, when two queens have the same colony odor, if they can be kept apart by means of perforated zinc both will continue to lay eggs in the same hive without interference. This condition will be allowed so long as the colony prospers, or until a dearth of honey comes, when the bees show a disposition to rob. They may then destroy one of the queens.

Bees that have been thrown into a box or pan, and then shaken or bumped again and again until they are demoralized or frightened, are much more tractable than those not so disturbed. Such bees, if made queenless just prior to shaking, and confined without combs or brood in a cool place for a few hours, will usually accept a queen at once. The factor of colony odor then apparently does not operate, for the bees are put out of their normal condition. (See Handling Live Bees at the close of Honey Exhibits.)

Very often the queens of two colonies may be made to exchange places. Two hives can be opened, during a honey flow, and before either colony can discover that it is queenless, the queens may often be exchanged; but when this exchange is made the precaution must be taken to open the hives very quietly, using but very little smoke. The idea seems to be to disturb the colony as little as possible, so that their normal condition may continue. Not suspecting any change in queens, the bees are not looking for any, and allow the new mother to go on where the previous queen left off. On the other hand, if either colony is queenless long enough so that it sets up a loud buzzing or a cry of distress, it will be pretty sure to ball any queen that may be given it.

Young bees just emerged will at any time accept any queen. When one desires

*If, on returning from a mating trip, a virgin queen by mistake enters a hive where there is an old laying queen she may, and very often does, supplant the old queen. The virgin is young and vigorous, and more than a match for the old queen full of eggs. Even though the colony odor may be lacking, the bees in this case accept the supplanter.

*We say "danger" of a battle. Queens will not always fight when so put together. The relative ages of the queens makes a great difference. If one queen be an old one there probably will be no fight, and even if there is, the young queen will be more than a match for the old one.

to introduce a valuable breeder on which he desires to take no chances whatsoever, he causes her to be released on a frame of very young or emerging bees; but consideration will be given to this later.

Virgin queens if just emerged, will usually be accepted by a colony, if not too long queenless, without the process of introducing or even of caging; but when one of these queens comes to be four or five days old she is much more difficult to introduce than a normal laying queen.

When a little honey is coming in, it is much easier to introduce and unite bees than during a dearth.

A queen in the height of her egg-laying will be accepted far more readily than one that has been deprived of egg-laying, as in the case of one that has been four or five days in the mails.

Some colonies are more nervous than others. To open a hive of such on an unfavorable day might arouse the inmates to a stinging fury. Indeed, such colonies will often ball and sting their own queen when the hive is opened if the day is unfavorable.

It is easier to introduce toward night, or after dark, than during the day. The reason for this is that after dark the excitement of the day has subsided. There is no chance for robbing and no reason for vigil. In short, bees are not *expecting* trouble and are not inclined to make any.

A fasting queen, or, rather a queen that is hungry, will usually ask for food, and hence will generally be treated more considerately than one that shows fear.

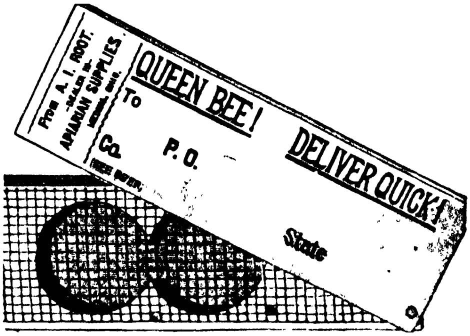
Having stated, therefore, the basic principles governing the relation of the queen to the bees the reader can now more intelligently proceed to methods of introduction, most of which are based on the theory that the queen to be introduced must first have acquired the colony odor of her new subjects.

The cages that are sent through the mails are supplied with soft bee candy (see Candy), so that in case the bees do not feed the queen, she will not starve. In some cages the bees release the queen by eating away the candy and letting her out. Other cages are so constructed that bees outside the cage must tunnel under the cage by tearing away the comb, in order to release her. In still other cases the apiarist himself liberates her after she has been confined the requisite length of time or until such time as she has acquired the colony odor.

Most of the cages are sent out by queen-breeders with directions for performing this operation; and it is usually safer for the beginner to follow these directions implicitly.

Mailing and Introducing Cage

The mailing and introducing cage that has been used over the country called the Benton is shown in the accompanying illustration. It consists of an oblong block



Benton mailing-cage. Postage on this cage is one cent. A larger size for longer distances, requires two cents.

of wood with three holes bored nearly through, one of the end holes being filled with soft candy (see Candy), and the other two left for occupancy by the bees and queen. On the back of the cover are printed full directions for introducing, and at each end of the cage is a small hole bored through lengthwise of the grain of the wood. One hole (next to the bees) is covered with a piece of perforated metal, secured in place with two small wire nails driven through the perforations. The other hole (the candy end) is covered with a piece of pasteboard slightly narrower than the hole. In this way the bees have an opportunity to taste the candy at the edges, and finally pull away the pasteboard entirely.

Oftentimes, after the cage has been through the mails, and been on the journey for several days, the bees in the cage will have consumed two-thirds or three-fourths of the candy. If those in the hive to which the queen is to be introduced gain access to the candy direct they would eat out what little there is of it in five or six hours, liberate the queen, and probably kill her. In order to accomplish introduction safely the cage should be on the frames (where the

bees can get acquainted with the queen) for at least 72* hours, and longer wherever practicable. As it takes generally from 48 to 72 hours for the bees to gnaw away the pasteboard before they can get at the candy, and from 12 to 24 hours to eat out the candy, at least 72 hours are assured before the bees can release the queen; and generally the time is longer—all the way from 72 to 144 hours. The pasteboard has another advantage, in that it makes the introduction entirely automatic. The one who receives the queen pries off the cover protecting the wire cloth, and then by the directions which he reads on the reverse side of this cover he learns that all he has to do is to lay the cage wire cloth down over the space between two brood-frames of the queenless colony, *and the bees do the rest.* It is not even necessary for him to open the hive to release the queen; indeed, he should let the colony entirely alone for four or five days, as opening the hive disturbs and annoys the bees to such an extent that often they will ball the queen, seeming to lay to her door what must be to them a great disturbance in having their home torn to pieces.

There are some who object to the use of the pasteboard on the ground that the bees may gnaw it away too soon and so release the queen before the bees will treat her kindly. These objectors tack a piece of tin over the candy. At the end of three or four days the tin is removed or revolved to one side, exposing the candy. As soon as the bees eat through, the queen is released. The use of the piece of tin makes sure that the queen will be confined long enough for the bees to get well acquainted with her before they get to her. Some colonies will not accept a queen unless she has been confined five or six days. This is more true during a dearth of honey.

The manner of filling a cage with bees and queen for mailing is to pick up the cage with the left hand in such a way that the thumb covers the hole over which the perforated metal has been nailed, but which, before the time of filling, should be revolved around to one side or taken off entirely. The queen is first to be picked up by the wings, and her head is pushed into the hole as far as possible. After she runs in, the thumb is placed over the hole. Worker bees are next picked up in like manner and poked in, selecting bees that are not too young nor too old, preferably those that are filling with honey from open cells. For the small cage there should be about a dozen attendants. If the cage is larger, two dozen may be used; and if it is extra large, four or five dozen. When cages are mailed during cold weather there should be more bees put in, to help keep up the animal heat.

*The length of time a queen should be confined before being released will depend upon whether honey is coming in or whether the colony is strong. If there is a dearth of honey and the bees are inclined to rob, the queen will need to be confined longer—possibly twice as long. A strong colony is more inclined to kill a queen than a weak one.

There are several sizes of these Benton cages, the larger ones being used for longer distances. The one for export is good for 100 miles through the mails, athough very often used for twice that distance. This may be called a combination mailing and introducing cage. Ordinarily, if one has much introducing to do it is better to use something especially adapted to the latter purpose alone. The Miller introducing-cage, mentioned next, has been used very largely.

Miller Introducing Cage

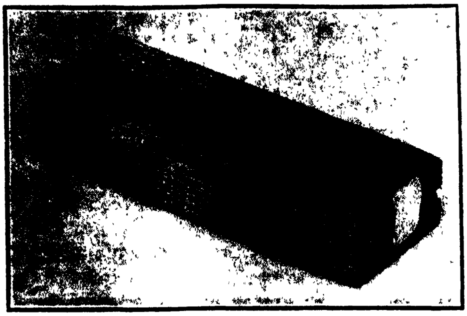
It is very convenient to have in the apiary small special cages for introducing and holding queens that come out with swarms until they can be introduced or disposed of. The Miller is an excellent one. It is especially handy for introducing young virgins. The cage is so flat it can slide in at the entrance without even removing the cover of the hive, and the bees will release the queen by the candy method. Yet for introducing fertile or valuable queens it should be inserted between two combs which are then drawn together until they hold the cage. The queen thus acquires the scent of the combs, brood, and the cluster, and hence when released will be more readily accepted.

Miller introducing cage.

This cage, like the Benton, will give very much better results if a piece of tin is nailed over the end. As already mentioned under the Benton cage, a piece of tin will keep the queen confined longer, and the author would advise "playing safe."

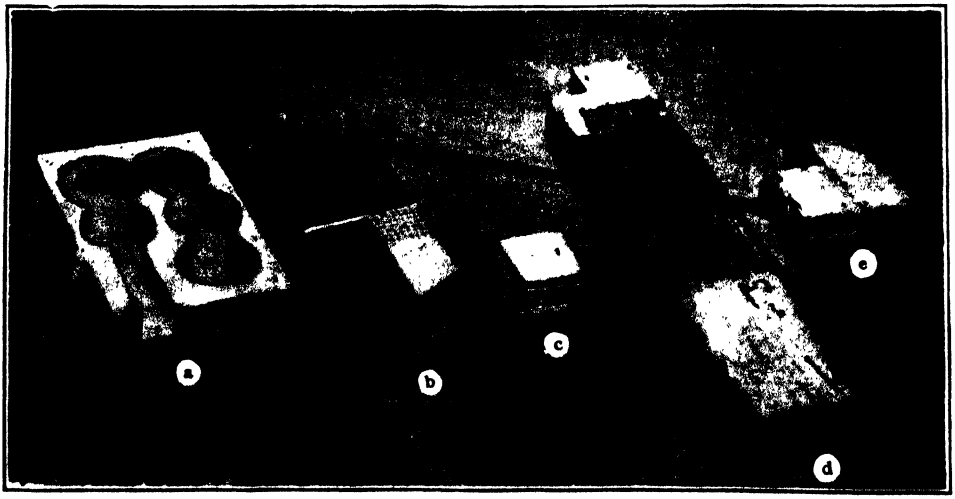
The Chantry Principle of Introducing

Introducing cages have been constructed to permit the bees to have access to the queen, through a single opening of perforated zinc, a day or two after inserting the introducing cage. This permits workers to pass in and out of the cage for about two days before she is released, carrying with them the odor of the laying queen. Since the bees do not attack a queen while she is in the cage, the perforated metal prevents any possibility of her being balled or killed. The bees on entering the cage begin to feed the queen, and since they subsequently go outside and mingle with the other bees of the colony, the queen is really introduced before she is released from the cage. By having two plugs of candy in the cage, a short one covered with the perforated metal, which the bees will eat out in about one day, and a long one which requires about four days for the bees to eat through, such a cage automatically gives the bees access to the queen through the perforated metal after one day, then releases her after four days. Some object to this arrangement and prefer to use a stopper of some sort over the perforation. This is removed at the end of the second day, when the bees enter the perforation.



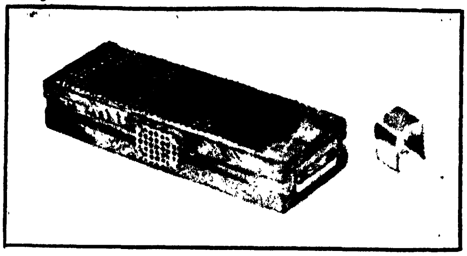
Benton cage with the opening over the zinc temporarily closed to prevent the bees from getting at the queen.

A much better application of this same principle is shown on next page. The U-shaped tin is slipped between the perforated metal and the end of the cage. This keeps the bees from eating out the candy while in the mails. When the cage is given to the bees the tin is removed. In about 12 hours a few bees eat out the candy back of the zinc, gain direct access to the queen, and at the same time release the attendant bees, which very often hinder safe introduction of the queen. Experience shows that the few bees that go through the perforated metal do not molest the queen,



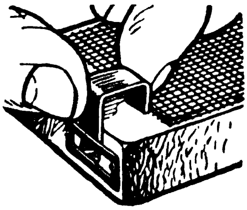
Introducing-cages with the Thomas Chantry principle applied. Letter a shows the cage with a long channel on the left side to receive candy. The other side has a piece of perforated queen excluder nailed over the hole that communicates with the interior cage. The space back of the perforated zinc is filled with candy, as also the entire space on the left side of the cage. In operation the bees will go through the perforated zinc and eat out the candy in about 24 hours; but it will take them two or three days to eat out the candy on the left side before the queen is released. In the meantime the bees in the hive have been going in and out through the perforated zinc, giving the queen the colony odor, b, c, d, e, are different applications of the same principle.

probably for the reason that there are not enough of them in the cage with her at any one time to cause them to ball her, as they would if she were loose in



Benton introducing-cage with the Thomas Chantry feature added. The U-shaped piece of tin slides over the perforation as shown in the next cut. The queen is caged in the hive in the regular way.

the whole colony. The going-in and going-out of the hive bees gradually gives the queen the odor of the colony. By the time the bees gnaw away the pasteboard on the other side and eat out the candy, two or three days will have elapsed. The queen can now get into the colony among



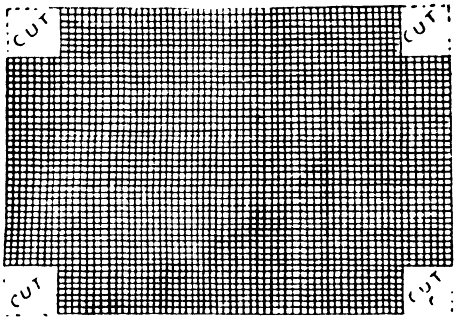
The standard Benton mailing cage with the Chantry feature added for introducing. See text.

the whole throng, when she will be accepted. The previous "nosing over" and feeding of the queen by the bees that went through the perforated metal three or four days before has given her the scent of the colony and freshened her up so that she is readily accepted.

Push-into-comb-cage Plan of Introducing

During 1911 and 1912, and again in 1919, there was considerable discussion in the bee journals concerning the method of introducing known as the push-into-comb-cage plan—that is to say, a plan which permits a queen's being caged over a few cells of honey and brood. This is accomplished by taking a square of wire cloth of suitable size and cutting a small square out of each of the four corners. The projecting ends are then folded down so as to make a wire-cloth box without bottom. This is pushed into a brood-comb with the queen under it. If it is not pushed in too deep, the bees will usually release her in from four to five days by gnawing under or tunneling under the wire cloth. Reports of this method of introducing have been uniformly favorable, and one reason for this is that the queen has immediate access to cells of honey; and if she should lay a few eggs in the comb before she is released she will have the odor of a laying queen, and this odor is one of the elements that go to make up successful introduction.

Some years ago a prominent queen-breeder offered to replace all queens that he sent through the mails, provided this plan of introduction were followed. He reported that it was so successful that



Wire-cloth corners cut out before folding to make the introduction cage that telescopes over the wooden part.

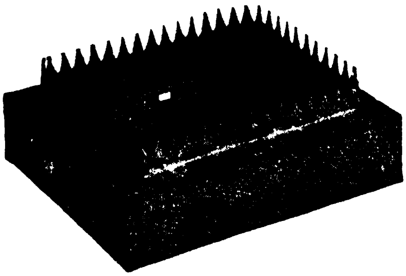
he scarcely ever had to replace a queen; and he believed that these replacements were due mainly to the fact that the recipient failed to carry out his instructions.

But one difficulty with a plan like this is that not every one will have on hand the proper material nor have the necessary skill for making a cage of this sort. Another and more serious difficulty is the problem of getting the queen transferred from the *mailing-cage* to the introducing-cage pushed into the comb, without injuring her or allowing her to get away during the process. Again, some push the cage into the comb so far that the bees fail to release her, although in such cases no harm results because the apiarist can remove the cage and release her.

The Smith Introducing-cage

This cage is a great improvement over the one just described, without its objections. As devised by Jay Smith, of Vincennes, Ind., it consists of a framework

of wood about 3 x 4 inches, covered on one side with wire cloth, the other side or edge having a series of teeth. In operation the teeth are pushed clear down into a piece of old comb containing some empty cells, cells of honey, and perhaps a little sealed brood. (If a new comb is used the cage will have to be held with a rubber band.)



Smith introducing-cage.

The queen is released on the comb, where she will find cells of honey and empty cells where she can lay. The Smith cage is carefully slipped over her and the teeth are pushed into the comb, where she is confined. No harm results if a few bees are with her. In a short time some of the brood may emerge, giving her cells in which she can lay. As soon as she lays she will have the egg-laying odor, which is always an important factor in introducing. A *laying* queen, or, rather one that has *just been laying*, is much more readily accepted than one just from the mail-bag, and that has not been laying for perhaps a week.

After the queen has been confined four or five days, but not until she has laid a few eggs, she is released. If she is treated kindly the hive is closed with as little disturbance as possible. If the bees seem a little hostile she is caught and caged again and held confined until such time as the bees will treat her as their mother.

Objection has been made to the Smith cage that it involves a lot of work, and also disfigures the comb; "but," says Mr. Smith, "if it provides a safe method of introducing a valuable queen, or any queen, in fact, it is worth it."

The Miller Smoke or Distress Method of Introducing

In 1913 Arthur C. Miller of Providence, R. I., introduced to the beekeeping world a new method of introducing queens. While one feature of it was old, the general procedure was original with Mr. Miller. Many years ago Henry Alley introduced queens by smudging the colony and queen with tobacco smoke. The plan was successful in many instances, but it was too often a failure and for that reason it seems to have been dropped. A. C. Miller's method, while similar only in the use of smoke, is enough different to make it practically new, and fairly reliable when directions are followed. There are conditions under which it is superior to any other plan of introducing queens, unless it be the Chantry method.

The plan has been used for requeening box hives with a considerable degree of success, and that, too, without finding or removing the old queen. But the success of this method of requeening without dequeening will depend on the superiority of the alien over the old queen; for by the smoke method both queens will be equally acceptable to the colony; and so far as the colony is concerned it appears to be a choice between the two, resulting in favor of the better queen.

How to Introduce by the Miller Smoke Method

The colony to receive a queen has its entrance reduced to about one square inch. Strips of wood, entrance cleats, or even grass or weeds, may be used for the purpose. The smoker bellows is worked until a white smoke is blown out —not a hot transparent smoke, as that would be destructive. Three or four long puffs are then blown in at the entrance. The amount may vary according to the size of the colony the condition of the fuel, and the fuel itself. At all events smoke is blown in at the entrance until the colony sets up a roar, which will take place in 10 or 20 *seconds*. If the roar does not take place it shows that not enough smoke has been used. The queen to be introduced is now run in, either from the fingers or from a queen-cage, and followed by a gentle puff of smoke, when the entrance is entirely closed, and left so for 10 or 15 *minutes*. At the expiration of that time it is reopened and the bees allowed to ventilate and quiet down, but the opening should not be wider than the original contraction of one inch, as the idea is to let the colony quiet down slowly from its distress. A full entrance is not given for an hour or more, and better not till the next day. Where grass or leaves are used they may be left to wilt and be pushed out by the bees. They are handy at outyards.

In order to make the plan work successfully there is one very important requirement. The colony should not be larger than one story and the frames and bees should occupy the whole of the story. It has been found impracticable to use this plan of introduction when only a third or a half of the hive is occupied with bees and combs, for the simple reason that the bees and queen may get out of the smoke and thus be remote from the smoke that induces the necessary condition—distress.

The theory of this method is based on the principle that bees in distress know no enemy or alien. It is important, also, that the queen be under the same spell; hence the directions to follow her up, after she goes into the hive, with a puff of smoke.

This method can be used for introducing virgin queens five or six days old. Such queens are usually rejected by a colony, or even by a nucleus. These six-day-old queens, after introduction by this plan, have been known to take a flight the very next day, and to be laying shortly afterward.

The question might be raised here, why the smoke or distress method is not used in the directions for introducing sent out by queen-breeders in the mailing-cages containing queens. The reason of it is, there are some very nice points in introducing by the distress method, and the average beginner will succeed better by the regular mailing cage with the Chantry feature added. As a general thing, queen-breeders use the cage plan for introducing virgins, which are usually quite young, because it takes less time to go through the procedure of introduction. An introducing-cage is inserted between the frames and left there. That is all there is to it. The smoke method of introducing requires considerable time and a great exactness of procedure, or the plan will fail.

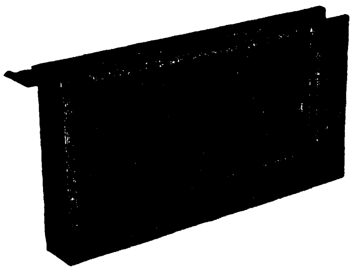
The question has been raised whether so much smoke inducing distress is not hard on the bees and the queen. The author believes that, when the queen is valuable, one of the other methods should be used.

A Sure Way of Introducing

There is one perfectly sure way of introducing a very valuable queen, such as a ten and twenty-five dollar breeder. Two or three frames of emerging brood are removed from several hives; every bee is shaken off, and the brood put into an empty hive contracted to a small space; and unless the weather is very warm, the whole is placed in a warm room, or over the hive of a strong colony with screen wire cloth between the two. The queen and her attendants are let loose in this hive, and the young bees, as they emerge, will soon make a colony. As several who have tried this plan have been so careless to leave the entrance open and let the queen get out, the beginner is warned especially to have the hive closed, so that no bee can by any possibility get out.* If the frames selected contain no unsealed brood, there will be very little loss; otherwise most of the larvae, having no bees to feed them, will starve. As soon as a few hundred bees emerge, the queen will be found with them, and they will soon make a cluster. When the combs have been taken from strong colonies, where the queen is laying hundreds of eggs in a day, the colony will become strong in a week or two. Three frames will do very well at first, and one or two more may be added in the course of a week or two. *No live bee* is to be given to the queen, and the hive must be kept in a warm place—the nearer 90 degrees F. the better.

The California Plan of Introducing

This makes use of the principle just described of putting the queen on emerging brood, only in this case the frame, brood, queen, and all are put in a large wire cage which is then set down in the center of the upper story of a strong colony. The brood is thus kept warm until it emerges.



The California introducing-cage.

When the young bees are all out the cage is removed and taken to a separate hive. The frame, bees, and queen are then removed and set in the hive. A comb of honey or a division-board is put next,

*The entrance can be opened in four or five days.

when the hive is closed and the entrance is contracted. In cool weather this is the only way a queen can be introduced to emerging bees.

This same method can be used for introducing to a strong colony. But in that case the cage is left in the hive for five days, at the end of which time it is removed and the comb, with its young bees and the queen, is put back, and the queen will mingle with the bees. This plan will not work, of course, if there is a virgin or a cell in the hive.

Introducing to Young Bees

There is another way that has proved to be good. In order to describe it an extract is made from an editorial in "Gleanings in Bee Culture," page 539, Vol. XXI.:

We have just received a consignment of 30 imported Italian queens, direct from Italy, by express. Every queen came through in good order, and they are now introduced into the apiary without the loss of one. Our method of introducing with this lot was something we had not tried before on so large a number of queens. We took four or five strong colonies, and divided them into 30 one-frame nuclei. This was done in the forenoon. In the afternoon we transferred the imported queens, without any attendants, to Miller introducing-cages, placing one in every nucleus above mentioned. Most of the queens were out at the expiration of two days, in good order, and they are now all out.

These newly divided nuclei will have old and young bees and more or less emerging brood. Before the imported queen is released, the old bees will have returned to the old stand, and it is these old bees that always make trouble in introducing. By the time the queen is released there are none but young bees, including those that were brought to the nucleus-stand and those that have emerged in the interim. These, of course, all being young, will accept their new mother without any trouble.*

*I've used the same plan with a full colony. Set the colony on a new stand, leaving on the old stand a hive with a frame of brood to catch the fielders. After introduction the hive may be returned.—C. C. Miller.

Direct Method of Introduction

Where it is desired to introduce a queen from a nucleus to a queenless colony, both in the same yard, the operation can usually be performed with safety and with very little labor, as follows: The colony to receive the queen should be made broodless a few hours in advance. Go to the nucleus and lift out two frames, bees and all, with the queen in between. Put these down in the center of the queenless colony; close up the hive and don't go near it for several days. The bees that have been queenless and broodless are crying for a mother. When she is given them with a large force of her own subjects, she seems to be protected, even if she does not have the odor of the new colony which, by the way, has been modified by the bees and brood given them from the other hive.

This is a modification of the Simmins direct method of introducing. It could not be used in the case of a queen sent through the mails.

The Simmins Fasting Method

While this has been discussed to a greater or less extent in the bee journals, the plan, while very simple, is not one that the author would recommend in the case of a valuable queen, or in any event to a beginner. It is as follows: The queen to be introduced should be put in a cage at night without attendants and without food. She should thus be confined for 30 minutes, when she must be released at dusk over the frames of the queenless colony. The hive is not to be opened again for 48 hours.

Dual Plan of Introducing

Another plan is to introduce two virgins or laying queens at one operation to save the necessary time it takes for the bees to get acquainted with the queen. This is described in detail under the head of Queen-rearing, to which the reader is directed.

To Introduce to Black Bees

As explained under Races of Bees, subhead Black Bees, the ordinary blacks of the South are inclined, when the hive is opened, to rush like a flock of sheep. In such a general scramble it is very difficult to find the queen in order that a queen of a better race may be introduced.

Mr. C. L. Sams, bee extension agent for North Carolina, who has had much to do with black bees, has worked out a plan to accomplish this that is as simple as it is quick in results.

To illustrate: Suppose we have six black colonies in modern hives with three supers on each, and all full of bees. After providing six queen-excluding honey-boards (see Drones and Extracting) blow a few strong drafts of smoke into the entrance of each hive, commencing at No. 1 and ending with No. 6. Go back to No. 1 and drum on the hive with a hammer or club for about 30 seconds. Next drum on No. 2 and so on until the last hive is finished. Go back to No. 1 again and drum on it and all the others in succession the same way. The smoke and double drumming will drive the queen and a lot of the bees up into the top story. Before the queen can go back, slip a queen-excluding honey-board under the top su-

per of each hive. Lift the cover of No. 1; examine the combs one by one, and shake the adhering bees into the top super. Blow a little smoke over the bees to drive them back into the super below, when, Mr. Sams says, if the work has been done right, the queen will be found on the queen-excluder nine out of ten times.

The queen in all the other top supers, found in the same way are of course destroyed and a queen of a better race introduced.

This method of requeening a black colony takes only about five minutes. To even find a black queen in a strong black colony might, by the old way of looking over the combs and into the hive and supers, take a whole hour with the chance that, in the mad scramble of running bees, she would not be seen at all.

How Soon Will an Introduced Queen Begin to Lay?

As a general thing, she may be expected to begin laying in two days; but sometimes, if the queen has been a long time prevented from laying, as in the case of an imported queen, she may not lay for three or four days, or even a week. If introduced in the fall, she may not commence laying until early spring, unless the colony is fed regularly every day for a week or more. This will usually start a queen that is good for anything if the weather is warm enough.

How to Tell Whether a Colony is Queenless or Not

Having discussed mailing and introducing cages, it may be pertinent at this point to give one of the prime essentials in successful introducing. The very first thing to be determined before an attempt to introduce is made, is to determine that the colony is *certainly* queenless. The fact that there are no eggs nor larvae in the hive, and that the queen can not be found, is not sufficient evidence that she is absent, although such a condition points that way. But during the earlier part of the summer there should be either brood or eggs of some kind if a queen is present. Yes, there should be eggs or brood clear up until the latter part of summer. In the fall in the northern states, or after the main honey flow is over, old queens generally stop laying and shrivel up in size so that a beginner might conclude that the colony is queenless, and therefore he must buy a queen. In attempting to introduce the new queen, of course he meets with failure, as she is stung to death, in all probability, and carried out at the hive -entrance. If eggs or larvae can not be found at any season of the year when *other* stocks are breeding, and the supposedly queenless colony builds cells on a frame of unsealed larvae given them, it may be concluded that the colony is queenless, and it will be safe to introduce a new queen. But when eggs, larvae, and sealed *worker brood* are found, the presence of queen-cells simply indicates that the bees are either preparing to supersede their queen or making ready to swarm. (See Swarming.)

The statement was made that old queens would stop laying in the fall if no honey was coming in. It should be noted that young queens will lay, flow or no flow, if there are sufficient bees and stores.

How Long Shall a Colony Be Queenless Before Attempting to Introduce?

The sooner a queen can be introduced to a colony after the old queen is destroyed, the better. One who supposes that a colony should be queenless one or more days before caging a new queen to be introduced is making a mistake. To dequeen and then send for another, expecting her to arrive at the right time is taking a long chance. If the new queen does not arrive until a week or ten days has elapsed the probabilities are the new queen when released will be killed by the bees. If queen cells are well under way the bees are quite inclined to want to do their own raising from the cells rather than an alien laying queen. If one of the cells casts a virgin there is no hope that the introduced queen will be accepted.

In the same way, if a colony is queenless long enough so that laying workers begin their scattered egg laying, the new queen will be sure to be killed. (See Laying Workers.)

The author strongly urges that the old queen should not be destroyed until the new one arrives. At the very time the old queen is killed the new one should be put in the hive. The directions for introducing should be carefully followed.

What to do if Bees Ball the Queen

Very often when the bees decide they will not accept the queen let loose among them they will begin to pull at her, pile on her in such numbers that they form a ball around her. Every bee in the ball

will seem intent on pulling her limb from limb. Unless the owner comes to her rescue she may be stung to death or be suffocated.

When queens were introduced in the old-fashioned way—that is, before cages were constructed so as to release queens automatically—much trouble was encountered by bees balling queens. If they were not ready to accept her when she was released by the apiarist, they were pretty sure to ball her. Right here is a point that it is well to observe: When the *bees* let out the queen they very rarely ball her. But when it is necessary for the *apiarist* to perform the work of opening the hive, and making a general disturbance, there is danger of balling. Suppose she is balled. The ball should be lifted out of the hive and smoke blown on it until the bees come off one by one; but hot smoke must not be blown on the queen. When the queen is found, get hold of her wings and pull the rest of the bees off from her by their wings. Cage her again as at first, and give her another trial. The advice has been given to drop the queen, when she is balled, into a vessel of lukewarm water. The angry bees will immediately desert the queen, when she can be easily taken out of the water, and recaged.

Another way of saving the queen without having to recage her is to carry a small oil can with a spring bottom, such as is used on a sewing machine, filled with thin syrup. When the bees are found balling her, saturate the ball thoroughly by pressing hard upon the bottom of the can, causing the syrup to penetrate through the ball. Close the hive and the bees will turn their attention to cleaning themselves and the queen, when she will be accepted without further trouble.

What to Do When the Queen Flies Away

Sometimes a beginner is very nervous, and by a few bungling motions may manage to let the queen escape from the hive where he expects to introduce her. Or this may happen: The queen may become a little alarmed because there are no bees about her, take wing direct from the frame and fly. In either case, one should step back immediately after opening the hive, and in 15 or 20 minutes she will probably return to the same spot and enter the hive. If she is not discovered in the hive in about half an hour, she may be found in one of the other hives near by. If a ball of bees somewhere down among the frames is found, it may be surmised that here is the queen that flew away, and that she has made a mistake, and entered the wrong hive.

Introducing Virgin Queens

As previously explained, a young virgin just emerged, generally weak, can usually be let loose in a queenless colony without caging, and be favorably received; but one from two to six days old is, as a rule, much more difficult to introduce than a laying queen; and one ten days old, more than old enough to be fertilized, is most difficult. Such queens can be introduced to a strong colony by using the Miller smoke method or the Smith-Chantry plan. Better give them a cell or a virgin just hatched, thus saving time and vexation; for even should the old virgin be accepted, she may be deprived of a leg, or be so deformed from rough treatment as to become in a large measure impaired for usefulness. Under the head of Queen-rearing are described "baby nuclei;" and, as already stated, it is much easier to introduce any queen, either virgin or laying, to a nucleus or weak force of bees than to a strong, vigorous colony; so if one would attempt to introduce four or five day-old virgins, give them to nuclei—the smaller and weaker the better.

Caution

When the bees cling closely to the wire cloth of the cage in which the queen is confined, and resist brushing away, it may be concluded that, if she were released, even though it may be three or four days after she was put in the hive, she will be balled immediately. Queens should never be released in any case until after the bees have stopped clinging to the wire cloth, especially if they are closely crowded. If, after six days, the bees cluster thus closely on the wire cloth, it may be assumed that there is *something* in the hive that they recognize as a queen. It may be laying workers. If so, the case is hopeless. It may be a small virgin that has eluded the eyes of the beekeeper. In that case, give a frame of unsealed brood. If no cells are built it may be assumed that a queen of some sort is in the hive and that any attempt to introduce an alien queen will meet with failure. When the tight clustering has ceased, the queen can be let loose. It is the author's opinion, however, that when the queen can be released by the candy plan automatically

she has a much better chance of being accepted. The mere act of opening a hive will sometimes cause the bees to rush at her in a frenzy as if she were to blame, and ball her, even though she is the mother of all the bees.

INVERTASE.—See Honey, Enzymes in.

INVERTING.—See Reversing.

INVERT SUGAR.—Chemically considered, this is a mixture of equal parts of the two sugars, dextrose and levulose, coming from the inversion or breaking-down of sucrose. In common terms, sucrose is the ordinary white sugar of commerce, such as beet sugar or cane sugar. This breaking-down of sucrose occurs when it is dissolved in water and boiled. The action then is very slow; but by the addition of a very small percentage of any acid the action is made more rapid. Hence, in the commercial preparation of this product white sugar is dissolved in water, then tartaric, acetic, phosphoric, or hydrochloric (muriatic) acid is added and the whole boiled. Of the two sugars of invert sugar, dextrose is easily crystallizable, while levulose remains a liquid under most conditions, but on long standing and under concentration the dextrose will crystallize out. As regards sweetness, dextrose is not so sweet as sucrose, while levulose is much sweeter; hence invert sugar is generally said to be sweeter than sucrose. (See Honey, Sweetness of.)

The preparation of invert sugar from sucrose by using water and tartaric acid was patented a number of years ago by Herzfeld in Germany. The proportion he uses is approximately as follows: cane sugar, 25 pounds; tartaric acid, ½ ounce (avoirdupois); water, 1 gallon. Bring to a boil and keep at that temperature for ½ to ¾ hour.

When prepared as above the product is liable to be yellow or brown in color, but it is perfectly possible by concentrating in vacuum or under reduced pressure to produce an invert sugar water-white. It can be made to appear like a high-grade clover honey. Its analysis is very similar to that of a clover honey.

During the preparation of this sugar a small amount of the levulose is broken down into furfurol or methylfurfurol. This product even in very small quantities gives strong color reactions with some reagents as resorcin—aniline acetate which forms a partial test for invert sugar.

Attempts have been made to make invert sugar which would not give these color reactions, but on a commercial scale they have not been altogether successful. The enzyme invertase (from yeast) will break down sucrose into dextrose and levulose without the formation of these furfurol bodies, but on concentration these bodies are formed. Other ways have been tried. It is true, though, that invert sugar can be made commercially that gives only slight color reactions, and improvements in manufacture of late years have yielded a product which has very much less of these furfurol bodies present, but the chemist does not need these color reactions altogether to prove the presence of commercial invert sugar in honey.

Commercial invert sugar is generally put on the market as a water-white liquid at the same price as granulated sugar. It has anywhere from 50 per cent to 75 per cent invert sugar, from 1.5 per cent to 30 per cent of sucrose, and from 18 per cent to 30 per cent of water. If a mineral acid as phosphoric, muriatic, or sulphuric is used for the inversion, this is generally partially neutralized with soda, and hence the product will have from 0.5 to 3.08 per cent of ash. Where acetic acid or phosphoric acid unneutralized is used, or where tartaric acid is used, there is practically no ash unless the sucrose carried some. For the detection of commercial invert sugar, see Adulteration and Honey, Science of.

ISLE OF WIGHT DISEASE.—See Diseases of Bees.

ITALIAN BEES.—See Races of Bees.

ITALIANIZING.—"How shall I Italianize?" and "When shall I do it?" There is generally a loss in removing a queen and substituting another, even where one has laying queens on hand; and where he is to use the same colony for rearing the queen, there is still greater loss. Under the head of Nucleus and Queen-rearing these points will be found fully discussed.

The average beginner at least can better afford to buy untested Italian queens rather than to rear his own on account of the inferior or black drones in his locality. Unless he uses drone-traps or

waits till the blacks and hybrids begin to kill off their drones before he attempts to mate his queens to select Italian drones of a colony that is queenless or one he is feeding, he will have impure matings. (See Hybrid.) Young Italian queens can be bought during late summer and early fall at low prices—so low indeed that it would hardly pay those who have only a few colonies to rear their own.

Probably a large majority of the extensive honey-producers likewise buy their queens because they argue that they can make more money producing honey than raising queens. As a general rule they will buy them in lots of a hundred at a time, when they are the cheapest and at prices usually 40 to 50 per cent lower than retail prices.

Not every honey-producer has a locality that is free from inferior drones, and by buying these queens from some reputable breeder he will improve his stock rather than have it revert backward.

Where one has plenty of time and would like the fun of raising his own queens the article on Queen-rearing should be read. He can purchase three or four choice tested queens, and rear his own queens from them after the honey flow. He should then put drone-traps on all his black and hybrid colonies, leaving only the Italian drones the freedom of the air. (See Drones.) Or, better yet, he should wait till the blacks and hybrids begin to kill off their drones, at which time he can secure pure matings if he feeds the colonies of Italians having drones. (See Hybrids.)

If the Italian breeders are bought in the spring or summer months, the old queens should not be removed until near the close of the summer honey flow. It may not be necessary to remove her at all as will be explained.

Instead of buying queens, cells from one of the breeders should be reared according to directions given under Queen-rearing. Before these cells become ripe, that is, just before the occupants are ready to emerge a nucleus, as many as are needed, is placed beside each honey producing colony to be requeened in the late summer or early in the fall. The entrances of the nuclei should be restricted and point the same way as the full colonies. When the cells are ripe one of them is given to each of the nuclei. In a few days there will be a laying queen. These nuclei, if a honey flow is on, will build up to four or five frames of bees and brood. If the nuclei are formed at the beginning of the honey flow all the combs may be occupied with bees, brood and honey.

Now to requeening or Italianizing with a minimum of work. Remove the cover from the colony with the old hybrid or black queen. Place the nucleus or colony with the new Italian queen on top and if conditions in the fall are right the bees will do the rest. The old queen will be destroyed by the bees or the young queen when the latter will become mother of both lots of bees. At the time the two lots of bees are put together watch to see that they do not fight.

This plan of uniting will not work unless there is a light honey flow on or unless it is so late in the fall that there is not much activity on the part of the bees.

At other times it will be necessary to use the newspaper plan described under Uniting. See also Requeening.

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LABELS FOR HONEY.—The Federal Food and Drugs Act has been amended by the "Gould Amendment," which changes the wording of the original act regarding the labeling of net weight and makes it compulsory for food in package form to bear a statement of its net weight, etc. The section as amended reads:

That, for the purpose of this Act, an article shall be deemed to be misbranded:
(1) ....
(2) ....
(3 If in package form, the quantity of the contents be not plainly and conspicuously marked on the outside of the package in terms of weight, measure, or numerical count. Provided, however, that reasonable variation shall be permitted, and tolerances and also exemptions as to small packages shall be established by rules and regulations made in accordance with the provisions of section three of this Act.

In the case of extracted honey, packages holding two ounces or less in weight, or one fluid ounce or less by measure, do not have to have the contents stated on the label; but for larger ones the statement must be on the label in a conspicuous place. The net weight so placed must be the actual net weight, and the variations in individual packages must be as often above as below to relieve one of prosecution under this act.

In the case of comb honey, "The net weight of the comb honey is considered to be the weight of the honey and comb, exclusive of the wooden section." As it is not practicable to mark the exact net weight on each, the sections are sorted into groups and on each section in the group should be marked its minimum net weight. (See Comb Honey, to Produce.) This may be marked in accordance with paragraph (h) of Food Inspection Decision No. 154. (A copy of this can be obtained by addressing the Bureau of Chemistry, United States Department of Agriculture, Washington, D. C.)

"The individual units must be marked, and the shipping case may be if desired. The marking should be done before their introduction into interstate commerce.

"While the regulations do not prescribe the manner of marking, as to whether a rubber stamp may be used, the law requires that the statements shall be plain and conspicuous. Stamping by means of aniline ink is frequently illegible, owing to failure to print or to the running of the ink. If such a stamp is used, care should be taken to make the statement plain and conspicuous, as required by the act."

The above is a letter signed by the Secretary of the Committee on Regulations, Net Weight, and Volume Law, and represents the committee's views as to which weight is to be considered final.

LARVAE.—Brood while in the worm state. See Brood and Brood-rearing; Behavior of Bees.

LAUREL.—See Poisonous Honey.

LAWS RELATING TO BEES.—The subject of bees takes up but little space in law. The old law writers, the men who really laid down the basic principles of our law during its formative period, classified bees and defined the rights of the keepers of bees in a few brief paragraphs, yet they seem to have covered the subject as fully as was necessary at the time at which they wrote.

As to legal opinions handed down in cases that have been adjudicated by a court of last resort, and which opinions form the bulk of our law of today, those pertaining to bees are very meager in volume. There have been, no doubt, many cases in the minor courts, but the decisions in such cases are binding only on the courts that decided them, and then only where there is a lack of higher authority. It matters not how much was involved in a case, nor how ably it was presented and argued, nor how learned and scholarly was the opinion handed down by the trial judge, nor what the verdict of the jury was, provided it was a jury case; unless the case was appealed to a court of last resort the decision is

not available law. Usually it is only the decisions that have been handed down in cases that have been appealed to a court of last resort that are published, and are available to the lawyers and the courts in general, that can be considered as law.

General Principles of Law Pertaining to Bees

But the fact that but little litigation concerning bees has reached the courts of last resort does not mean that the law governing bees and their keeping was in an undetermined state. Law deals primarily with principles; the subject matter is secondary. To ascertain what the law is in a given instance all that is really necessary to do is to apply an established principle of law to the facts in the case. For example, to steal the property of another person is larceny, and it matters not whether the subject matter stolen be an automobile, a caged lion, an aeroplane, or a hive of bees, as it is the act that constitutes the offense.

The law laid down by Blackstone and other law writers of his time and of times prior is briefly as follows:

That bees are wild by nature; therefore, though they swarm upon your tree they are not yours until you have hived them, any more than the birds that have their nests in your trees or the rabbits that run wild through your fields. But when they have been hived by you they are your property the same as any other wild animal that you may have reduced to possession. Animals that are wild by nature and have been captured by you, should they escape, you still have a right in if you follow them with the idea of recovery. A swarm of bees that has left your hive continues to be yours so long as you can keep them in sight and under probability of recovery; 2 Blackstone Com. 392; Coopers Justinian Inst. Lib. 2, tit. 1, No. 14; Wood's Civil Law, bk. 2, chap. 3, p. 103; Domat's Civil Law, vol. 1, bk. 3, pt. 1. Subd. 7, No. 2133; Puffendorf's Law of Nature, 4, chap. 6, No. 5; Code Napoleon No. 524; Bracton's Law, 2, chap. 1, No. 3; and see notes in 40 L. R. A. 687; 62 L. R. A. 133.

During the early development of our eastern states the general principle of law relative to ownership of bees was adjudicated in a number of cases. The questions raised and the decisions rendered are briefly as follows: Where bees have escaped and so properly may be considered as wild bees and without any owner at the time of their discovery it has been held that such bees in a tree belong to the owner of the soil where the tree stands. Merrils vs. Goodwin, 1 Root 209; Ferguson vs. Miller, 1 Cow. 243; 13 Am. Dec. 519; Goff vs. Kilts, 15 Wend. 550.

That bees are *ferae naturae*, that is, wild by nature, but when hived and reclaimed may be subject of ownership. State vs. Murphy, 8 Blackf. 498; Gillet vs. Mason, 7 Johns. 16; Rexroth vs. Coon, 15 R. I. 35; 23 Atl. 37.

But the finding of a swarm of bees in a tree on the land of another, marking the tree and notifying the owner of the land does not give the finder such property in the honey as will entitle him to maintain trover for the honey. Fisher vs. Steward, Smith 60.

Where one discovers wild bees in a tree, and obtains license from the owner of the land to take possession of them, and marks the tree with his initials, he gains no property in them until he takes them into his possession. Gillett vs. Mason, and Ferguson vs. Miller, supra.

Where bees take up their abode in a tree, they belong to the owner of the soil even though they are reclaimed; but if they have been reclaimed and their owner is able to identify them as in a case where he followed the bees and saw them enter the tree, they do not belong to the owner of the soil, but to him who had former possession, although he can not enter upon the land of the owner of the tree and retake them without subjecting himself to an action for trespass. Goff vs. Kilts, 15 Wend. 550.

In a case decided in 1898 and entitled State of Iowa vs. Victor Repp, 104 Iowa, 305, 40, L. R. A. 687, it was held that the mere finding of bees in a tree on the land of another did not give the finder any title to the bees or to the tree. The facts were, one Stevens who found the bees trespassed on the land and hived the bees in a gum belonging to another. The defendant Repp removed the bees from where they had been hived and was for that act arrested and tried for larceny. Stevens, the man who hived the bees, being the complaining witness. The trial court convicted Repp, and the case was appealed to the Iowa Supreme Court. The court reversed the trial court, and in rendering the decision, Justice Ladd said: "The

title to a thing *fera naturae* can not be created by the act of one who was at the moment a trespasser, and Stevens obtained no interest in the bees by the mere wrongful transfer of the bees from the tree to the gum. Having neither title nor possession he had no interest then in the subject of the larceny. As the information alleged ownership in Stevens, and the case was tried on that theory, we need make no inquiry as to any taking from Cody (the owner of the land.)"

Where Bees Should be Located

Bees should be located by their owner so that in the natural course of events they will not molest others. If a keeper of bees locates his bees so that they will be prone to attack other people or their horses he is guilty of negligence. A case in point is Parsons vs. Manser, 119 Iowa 92, 62 L. R. A. 132, decided in 1903, the facts of the case being that the beekeeper had a hitching post in front of his house. This post was located in the public highway; about 25 feet from the post, but in the beekeeper's yard, there were two bee-gums. The plaintiff, Parsons, was a medicine peddler. He called at Manser's house and tied his horses to the hitching post. The bees attacked the horses and stung them to death. The beekeeper was held liable for the death of the horses, as the evidence showed that he was aware of the fact that the bees would attack horses when hitched to the post. A beekeeper is not liable, however, unless he has been negligent. In other words, the beekeeper must have been at fault, and if through no fault of the beekeeper some other person is injured, the beekeeper is not liable. It was so held in a New York case, Earl vs. Van Alstine, 8 Barb. 630, which was an action for damages caused by plaintiff's horses being stung, resulting in the death of one of the horses.

Earl vs. Van Alstine

The facts in this case were: That Van Alstine was the owner of 15 hives of bees. The bees were kept in his yard, adjoining the public highway. Earl, the plaintiff in the case, was traveling along the highway with a team of horses, and when he passed Van Alstine's place the bees attacked his horses and stung them so severely one died.

Action was brought in the Justice's Court and Earl secured judgment for the sum of $7.25 and costs. The case was appealed to the County Court of Wayne County where the judgment was reversed. From the County Court the case was appealed to the Supreme Court, Seventh Judicial District, which court affirmed the decision of the County Court, the decision being of date June 4, 1850.

The opinion was written by Justice Selden, and he discussed very thoroughly the questions involved, the opinion being in part as follows:

This case presents two questions:

1. Is any one who keeps bees liable, at all events, for any injury they may do?

2. Did the defendant keep those bees in an improper manner or place, so as to render him liable on that account?

It is insisted by the plaintiff that, while the proprietor of animals of a tame or domestic nature (domitae naturae) is liable for injuries done by them (aside from trespasses upon the soil) only after notice of some vicious habit or propensity of such animal; that one who keeps animals ferae naturae is responsible at all events for any injury they may do, and that as bees belong to the latter class, it follows, of course, that the defendant is liable.

In order to determine this question, upon which no direct or controlling authority exists that I have been able to find, it becomes necessary to look into the principles upon which one who owns or keeps animals is liable for their vicious acts. It will be found upon examination of the authorities upon this subject that this classification of animals by the common law into animals ferae naturae and domitae naturae has reference mainly, if not exclusively, to right of property which may be acquired in them; those of the latter class being the subject of absolute and permanent ownership, while in regards to the former only a qualified property can exist, and the distinction is based upon the extent to which they can be domesticated or brought under the control and dominion of man, and not at all upon the ferocity of their disposition or their proneness to do mischief. For instance, the dog, some species of which are extremely savage and ferocious, is uniformly classed among animals domitae naturae, while the hare, rabbit, and dove are termed ferae naturae, although completely harmless. It would not be natural to suppose that a classification adopted with exclusive reference to one quality of animals could be safely used to define and regulate the responsibilities growing out of other and different qualities; nor would it accord with that just analysis and logical accuracy which distinguishes the common law, that it should be resorted to for that purpose.

Chitty, under the head of actions on the case for negligence, gives the following rule: "The owner of domestic or other animals, not naturally inclined to do mischief, as dogs, horses, and oxen, is not liable for any injury committed by them to the person or personal property unless it can be shown that he previously had notice of the animal's mischievous propensity;" Chitty Plead. 82. This accurate elementary writer did not fall into the error of applying the rule to the whole of the class of animals domitae, but adds the qualifications, "not naturally inclined to do mischief." By his arrangement of the subject, too, he confirms the view of Peake that the liability is based upon negligence.

These authorities seems to me to point to the following conclusions:

1. That one who owns or keeps an animal of any kind becomes liable for any injury the animal may do, only on the ground of some actual or presumed negligence on his part.

2. That it is essential to the proof of negli-

gence and sufficient evidence thereof that the owner be shown to have notice of the propensity of the animal to do mischief.

3. That proof that the animal is of a savage and ferocious nature is equivalent to proof of express notice. In such case notice is presumed.

. . . . . Having shown then, I think clearly, that the liability does not depend upon the classification of the animal doing the injury, but upon its propensity to do mischief, it remains to be considered whether bees are animals of so ferocious a disposition that any one who keeps them, under any circumstances, does so at his peril. If it is necessary for the plaintiff to aver and prove the mischievous nature of the animal, nothing of the kind has been done in this case; but if the courts are to take judicial notice of the nature of things so familiar to man as bees, which I suppose they would be justified in doing, then I would observe that however it may have been anciently, in modern days the bee has become as completely domesticated as the ox or cow. Its habits and instincts have been studied, and through the knowledge thus acquired it can be controlled and managed with nearly as much certainty as any of the domesticated animals; and although it may be proper still to classify it among those ferae naturae, it must nevertheless be regarded as coming very near the dividing line, and in regards to its propensities to do mischief, I apprehend that such a thing as a serious injury to person or property from its attacks is very rare, not occurring in ratio more frequent certainly than injuries arising from the kick of a horse or a bite of a dog.

There is one rule to be extracted from the authorities to which I have referred, not yet noticed, and that is that the law looks with more favor upon the keeping of animals useful to man than such as are noxious and useless. And the keeping of the one, although in some rare instances they may do injury, will be tolerated and encouraged, while there is nothing to excuse the keeping of the other. In the case of Vrooman vs. Lawyer, 13 John. Rep. 339, the court says: "If damage be done by any animal kept for use or convenience, the owner is not liable to an action without notice." The utility of bees no one will question, and hence there is nothing to call for the application of a very stringent rule to the case. Upon the whole, therefore, I am clearly of the opinion that the owner of bees is not liable at all events for any accidental injury they may do. The question is still left whether the keeping of bees so near the highway subjects the defendant to a responsibility, which would not otherwise rest upon him. I consider this question substantially disposed of by the evidence in the case. It appears that the bees had been kept in the same situation for eight or nine years, and no proof was offered of the slightest injury having ever been done by them. On the contrary, some of the witnesses testified that they had lived in the neighborhood and had been in the habit of passing and repassing frequently with teams and otherwise without ever having been molested. This rebuts the idea of notice to the defendant, either from the nature of the bees or otherwise, that it would be dangerous to keep them in that situation, and of course, upon the principles already settled, he could not be held liable.

The judgment of the County Court must be affirmed.

The two cases last mentioned (Parsons vs. Manser and Earl vs. Van Alstine) are in perfect harmony. In the first case the evidence showed the beekeeper was at fault; in the second, no negligence of the beekeeper was proven. **From these** cases it can be seen that the **law governing** the location of bees is **very simple.** For a beekeeper not to be **liable for any** injury that his bees may **inflict on some** other person who is acting **within his** rights the bees should be **located in such** a way that the beekeeper **knows or should** ordinarily know that they **will not be** troublesome, for if he has **knowledge that** in the course of ordinary **events the bees** in the position where they **are located** are liable to molest others, **he can be** held to answer for whatever **damages** they may commit, and **that means not** only actual but punitive damages **should** the facts warrant.

Bees Not a Nuisance

The liability of a beekeeper for any injury done by the bees to another person or the property of another rests on the doctrine of negligence, and not on the doctrine or theory that bees are a nuisance *per se*; that is, in themselves a nuisance. In the case of Petey Manufacturing Co. vs. Dryden (Del.) 5 Pen. 166; 62 Atl. 1056, the court used the following language: "The keeping of bees is recognized as proper and beneficial and it seems to us that the liability of the owner as keeper thereof for any injury done by them to the person or property of another rests on the doctrine of negligence." Also see Cooley on Torts, 349.

As all beekeepers know, there is always a chance of people being stung by bees in flight, and particularly when bees are loaded. Very often they become entangled in the hair, and as a result some one receives a sting. The bee has no intention of stinging, and so far as it is concerned the matter is an accident. However, if there is an apiary near by, the person stung generally blames the beekeeper. During the past two seasons there have been a number of cases tried in police courts, where action has been instituted against some beekeeper for such stings, the person quite generally being stung while traversing the highway. **In every one of such cases, so far as known to the writer, such cases have been decided in favor of the beekeeper, for the reason that the complaining witness was unable to prove that the sting received resulted from a bee, the property of or under control of the beekeeper made defendant.**

City Ordinance Declaring Bees a Nuisance

The right to follow any of the ordinary callings of life, to pursue any lawful business vocation, is one of the privileges of citizens of this country; but it must be done in such a manner as is not inconsistent with the equal rights of others. Butchers' Union vs. Crescent City, etc., 111 U. S. 746; 28 L. Ed. 591.

A city has a right under what is termed in law "Police Power" to pass ordinances for the public welfare, even though the thing prohibited limits and restricts some person in the exercise of a constitutional right, if the act is for the public health and welfare. For example, laws prohibiting the maintaining of slaughter-houses in certain districts and the prohibiting of livery stables on certain streets have been held to be valid police legislation. But the act specified in the ordinance must, in the particular instance mention therein, be a nuisance. The mere fact that the city has passed an ordinance does not of itself make it so unless the bees are in fact a nuisance.

Arkadelphia vs. Clark

Arkadelphia vs. Clark, 52 Ark. 23: 11 S. W. 957, is a case in point. This particular case was decided in 1889, and a report and history of it was published by Thomas G. Newman, then General Manager of the National Beekeepers' Union, for free distribution to the members. From the history of the case as given by Newman it seems that Z. A. Clark, the defendant in the case, was not in political harmony with those in power. He was a beekeeper, and it was sought to punish him and get rid of his presence by prohibiting the keeping of bees within the corporate limits of the city of Arkadelphia. So in May, 1887, the Arkadelphia city council adopted an ordinance which read:

> Be it ordained by the Council of the City of Arkadelphia, That it shall be unlawful for any person or persons to own, keep, or raise bees in the City of Arkadelphia, the same having been declared a nuisance.
>
> That any person or persons keeping or owning bees in the City of Arkadelphia are hereby notified to remove the same from the corporate limits of Arkadelphia within thirty days from the date thereof.

The ordinance also provided a penalty of not less than $5.00 nor more than $25.00 for violation of the ordinance.

In June, 1887, Clark was given notice to remove his bees. This he did not do, and he was arrested on January 2, 1888, and fined day after day for ten successive days. He did not pay his fines, so was committed to jail by order of the mayor of Arkadelphia. Being a member of the National Beekeepers' Union, he appealed to it for protection; and as it was considered that Clark was in the right the National Beekeepers' Union engaged attorneys to defend the suit.

The decision as handed down by the Supreme Court was that "Neither the keeping, owning, or raising of bees is, in itself, a nuisance. Bees may become a nuisance in a city, but whether they are so or not is a question to be judicially determined in each case. The ordinance under consideration undertakes to make each of the acts named a nuisance without regard to the fact whether it is or not, or whether the bees in general have become a nuisance in the city. It is therefore too broad and is invalid."

Another instance where a city tried to prohibit beekeeping within the city occurred in 1901, when the city of Rochester, N. Y., enacted an ordinance similar to the one enacted by the city of Arkadelphia. It was repealed on the ground that it was unconstitutional.

W. R. Taunton, a member of the National Beekeepers' Association, was living in Rochester. The National Association had an investigation made, by which it was ascertained that Taunton was handling his bees in such a manner as not to annoy his neighbors, and that he ought to be protected, so advised him not to remove his bees, and assured him that in case of trouble the association would defend him.

Taunton was arrested for refusing to comply with the ordinance and was tried in police court. The defense was that the ordinance was unconstitutional and void, and it was so held by the court, and the defendant was discharged.

A case where the bees were, from the evidence given at the trial, declared to be a nuisance, is that of Olmsted vs. Rich, 25 N. Y. S. R. 271; 6 N. Y. Supp. 826, which was an action for an injunction prohibiting the keeping of bees in a certain place and for $1500 damages. At the trial the evidence showed that the beekeeper had a large number of hives of bees on a village lot adjoining the man who desired the injunction, and that during the spring and summer the bees interfered with the enjoyment of his premises. The bees

drove him and his servants and guests from his garden and grounds, stinging them, and otherwise making his dwelling and premises unfit and unsafe for habitation, constituting a nuisance. The verdict was against the beekeeper for six cents damage and a permanent injunction was granted, which was affirmed on appeal.

The Case at Holmesburg, Pa.

In 1934, Judge Harry S. McDevitt went back over centuries of legal history citing legal precedents in denying an injunction to restrain Joseph Rexer from keeping bees on his property at 8062 Fairview Street, Holmesburg, Pa.

It appears that Herbert D. Allman and Drue Allman, nurserymen, claimed "that Rexer's bees stung the Allmans, their employees, their guest, their wash and hot house flowers."

The judge held that bees were not vicious by nature; that they were not a nuisance because they were bees; that there were other bees in the vicinity as well as those of Rexer's, and that no proof had been advanced that the Rexer bees were the offending ones.

The judge not only dismissed the Allmans' suit but ordered them to pay the costs and in addition to all this praised the bees for their industry.

The Case at Tracy, Minn.

In 1934, Assistant Attorney-General of Minnesota, David J. Erickson, has ruled that an ordinance declaring bees a nuisance and excluding them from the city can not be legally drawn and he so notified Wm. R. Mitchell, city attorney at Tracy, Minnesota.

Attorney General Erickson cited the Arkansas supreme court decision, which held that neither the keeping, raising, nor owning of bees is a nuisance, and that this decision would apply to Minnesota.

Both of these decisions are important in that they add to the already strong array of precedents in favor of the bees.

Shipping Bees by Rail

The general rule is, that it is the duty of a common carrier to carry all freight that is tendered to be carried. As to the right to refuse shipment, in Porcher vs. Northeastern R. R. Co. 14 Rich. L. 181, the court quoted with approval from Story, Bailments: "If he (the carrier) refuses to take charge of the goods because his coach is full or because they are of a nature which will at times expose them to extraordinary danger or to popular rage because he has no convenient means of carrying such goods with security, etc., these will funish reasonable grounds for his refusal, and will, if true, be a sufficient legal defense to a suit for the non-carriage of goods." In Boyd vs. Moses, 74 U. S. 7 Wall 316; 19 L. Ed. 192, it was held that "A carrier may refuse to take lard which is packed in such a condition that it can not be carried without injury to the rest of the cargo." Also see note in 36 L. R. A. 649.

The law, therefore, appears to be that if bees are properly packed for shipment it is the duty of a common carrier of freight to take them, but should they be not properly packed for shipment so that the carrier could refuse the shipment on any of the previously stated grounds he could legally refuse to accept them.

Liability of Railroads for Loss in Shipment of Bees

It is the duty of a railroad to furnish a proper car when they undertake the transportation of bees; and the railroad company with which the contract for shipment is made is liable for injury caused by a defective car, even though the car has left the initial road and was in possession of a connecting railroad. This was held to be the law in the case of International and G. N. R. R. vs. Aten, a Texas case reported in 81 S. W. 346, in which case the station agent was informed that the car was desired for a shipment of bees. The car furnished was not suitable, and by reason of the car not being suitable the bees were injured on a connecting road.

The courts have also held that carrier by water is liable, when it undertakes to transport bees, not only for injury from shipwreck due to its negligence, but also for neglect after shipwreck when salvage is possible. Bixby vs. Deemar, 54 Fed. Rep. 718.

Bees Injurious to Fruit

That bees are an essential agent in the pollination of fruit blossoms, and that they are never injurious to sound fruit, or in any way injure fruit trees are matters that are firmly established.

That bees do not injure fruit or fruit trees has also been established in a court of justice to the satisfaction of a jury. (See Bees Exonerated by Jury, page 96.)

Fruit Drying

Where fruit is being dried it is another matter, and there is no doubt that damage is done by bees to drying fruit if they are allowed to work upon it. The sugar that bees carry away from the drying fruit is just that amount deducted from the weight of the fruit, besides injuring its appearance. Bees can also make themselves a nuisance to those at work where fruit is being dried. In one instance known to the writer, a beekeeper in California, because there had been a poor season in the mountains, brought his bees to the small town where he lived. The principal crop in and about this town was fruit, and when the apricot-drying season came on the bees became so thick on the newly cut fruit that a large force of girls who were cutting the fruit had to be laid off and operations stopped for the day. That night the beekeeper removed his bees some three miles away, and the next day made a satisfactory settlement with the fruit-dryer, and so the trouble ended.

Bees Killed by Smelter Fumes

The fact that bees can be killed by smelter fumes became generally known in 1907, as a result of the settlement by arbitration, between the beekeepers and the smelter interests of the Salt Lake Valley, Utah. In this settlement, which ended a two-year conference between the parties, the beekeepers were paid the sum of $60,000 by the smelter interests.

How destructive the smelter fumes can be to bees, and the amount of damage that was actually suffered can be realized from the fact that, according to E. S. Lovesy, one of the beekeepers of the Salt Lake Valley, ten years prior to 1907 the Salt Lake Valley had over ten thousand colonies of bees. It was the banner bee and honey county of the state. Ten years later, at the date of the settlement, it was doubtful if there were ten colonies of bees to be found within the valley. At first when the bees died off the beekeepers, not realizing the cause, bought more bees, only to have those die off more rapidly than the first. So, while the sum of $60,000 was a large amount of money in the year 1907, it really covered but a small part of the actual loss suffered by the beekeepers. However, the beekeepers at the time considered that it was better to arbitrate than to go to court with the matter.

Ontario Cases

In 1917, ten years after the settlement of the Salt Lake smelter cases, the beekeepers in the vicinity of the Coniagas Reduction Company's plant at Thorold, Ontario, brought action against that company for the loss of bees by smelter fumes. It was claimed that something like 700 colonies of bees had been killed outright. The beekeepers who had suffered brought a joint action against the company. The best legal talent available was employed by the parties, and the matter was tried before the Supreme Court of St. Catherine's. That the side of the beekeepers was well presented is evidenced by the fact that E. R. Root, editor of Gleanings in Bee Culture, and Prof. Morley Pettit, of the Apicultural School of Guelph, were called as expert witnesses. These experts testified to facts concerning flights of bees, symptoms of various diseases, poisoning, etc. However, the evidence was not sufficient to satisfy his lordship, Judge C. J. Falconbridge, that the death of the bees resulted from the fumes from the smelter, his judgment as rendered being as follows:

> Plaintiffs have to prove to the satisfaction of a judge or jury that the loss from which they have suffered was caused by the wrongful acts of defendants, viz., by the emission from their works of noxious vapors or substances which killed the bees. It is not sufficient for me to find that the destruction of the bees might have been—and indeed probably was—caused by the works of the defendant. The question is, has this been proved? There seem to be too many elements of doubt for me to resolve them all in plaintiff's favor. The plaintiffs have failed to prove their case to my reasonable satisfaction and their action must be dismissed with costs. Newhouse vs. C. R. Co. 21 Ontario W. N. 136.

At the time the foregoing decision was handed down there were nine other actions pending against the Coniagas Reduction Company, that were also dismissed at the same time. In view of the experience of the beekeepers in the Salt Lake Valley, and in a later case referred to below, it really seems that the Canadian judge was hard to convince.

Case of Lynch vs. Magma Copper Co.

The latest litigation as a result of loss of bees by smelter fumes was tried in 1927, the case being that of Jeannie E. Lynch vs. Magma Copper Company. The case was tried during the month of April, 1927, in the Superior Court of Pinal County, Arizona, Maurice Blumenthal, of Phoenix, Arizona, appearing as attorney for the plaintiff. The allega-

tions in plaintiff's complaint as to the manner in which the bees were killed were as follows:

That subsequent to the 22d day of March, 1924, the exact period being unknown to the plaintiff, the defendant, in using said smelter, discharged into the air and atmosphere noxious, foul, and poisonous gases, smoke fumes, and flue dust, some of which contained sulphur and other dangerous and poisonous materials, the exact contents of which to plaintiff is unknown; that said noxious, foul and poisonous gases, smoke, fumes, and flue dust so discharged by defendant came into, over, and upon an apiary owned by plaintiff, situated about 3500 feet more or less in a southeasterly direction from said smelter, killing all the bees therein.

The plaintiff (who, by the way, is a dentist) claimed to have suffered the loss of 27 colonies of bees, and set the valuation at $20.00 per colony. During the course of the trial the copper company produced witnesses that set a valuation of $10.00 per colony on the bees. The case went to the jury on the decisive point, as to whether or not the smelter smoke was responsible for the death of the bees. The jury found that the smelter smoke was the cause of death, and brought in a verdict for the beekeeper. As to the valuation of the bees, however, the jury saw fit to accept the copper company's valuation and found that the bees were worth but $10.00 per colony.

Following the verdict against them the smelter company exercised their right to make a motion for a new trial. This motion, after much delay, was finally heard and disposed of during May, 1928, more than a year after the trial. The ruling on this motion was also against the smelter company.

LAWS RELATING TO FOULBROOD.—In controlling bee diseases in a community, past experience has shown that it is necessary that every beekeeper do his part; otherwise the work done by individuals is largely nullified by the carelessness or neglect of a few. Where all the beekeepers are progressive, a simple plan of co-operation should be enough; but unfortunately, there are in almost all communites some beekeepers who are either ignorant, careless, or wilfully negligent. If any of these will not voluntarily care for their bees there must be some legal means of compelling them to abate a public nuisance when disease appears among their colonies.

Laws providing for inspection of apiaries with the object of controlling diseases are, therefore, drafted primarily for the beekeeper who does not voluntarily treat diseased colonies. The progressive beekeeper needs no such law to compel him to do his duty. The inspector of apiaries, however, in actual practice is much more than a police officer; in fact, his police duties are but a small part of his work. However the law may be worded, the good which an inspector does is due in the greater part to his work as an educator. It is the duty of the inspector specified in the law in most cases, to instruct the beekeepers how to know disease and how and when to treat.

Hawaii and the following states now have laws of some kind providing for inspection: Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Texas, Utah, Vermont, Washington, West Virginia. Somewhat similar laws exist in New Zealand, some states in Australia, Ontario, Ireland, and parts of Europe. The beekeepers in several other states are now agitating the passage of bee-disease laws.

These laws may be divided into three groups: (1) those in which the work is done by men employed by the state; (2) those in which the county authorities appoint inspectors for the county only; and (3) those in which county and state work together, as in Ohio.

In California the county plan for inspection gave only fair results. The counties are very large, some of them as large or larger than some states in the East. However, it was felt that the state ought to have one general state bee inspector or state bee adviser. California now has a law state-wide in its application, and the foulbrood situation has greatly improved since its enactment.

The chief weakness in county inspection not supervised by the state is the lack of co-operation among the inspectors in neighboring counties. The differences in the ordinances or laws necessarily make inspection in one county more rigid than in another. In some cases there is not only a lack of co-operation, but too often a jealousy between the various bee inspectors. In California this was remedied by

having a state apiarist who has supervision of the inspectors or bee advisors of the various countries. Where the states are smaller and likewise the counties, the scheme of county inspection has proven to be a failure.

Practically all laws in force, whether state or county, provide for inspection of apiaries; penalties for resisting the entrance of the inspector on the premises; penalties for failing to comply with instructions for treatment if the bees are found to be diseased, and penalties for selling or bartering bees, hives, or appliances before the apiary has been pronounced free of disease. Usually additional provision is made for more than one inspection of queen-rearing yards. This is very wise, as they might spread infection far and wide.

It was formerly believed that shaking a colony affected with American foulbrood on to comb foundation would cure the disease; but experience shows that there have been too many recurrences. (See Foulbrood, page 310.) It is the judgment of practically every bee inspector in the country that burning bees, combs and all infected material is the only sane and safe treatment. Most state laws give the bee inspector wide discretionary powers. He can, if he thinks necessary, burn hives, bees, combs and all, or shake.

The Ohio foulbrood law is here given as one that confers these powers and is one of the best in force:

Section 1165. The director of agriculture shall appoint a competent entomologist as state apiarist and such number of deputy state apiarists as may be necessary to carry out the provisions of this act. Said state apiarists and deputy state apiarists shall be vested with the powers of police officers in the enforcement of the provisions of this act and shall be furnished with official badges or other insignia of authority which shall be carried while on duty.

Section 1165-1. The director of agriculture is hereby empowered to make and enforce such rules and orders as in his judgment may be necessary to control, eradicate or prevent the introduction, spread or dissemination of any and all bee diseases. In the control or eradication of dangerous bee diseases the director of agriculture may destroy by burning or otherwise any infected bees, hives, honey or appliances that he may deem necessary for such control or eradication, without remuneration to the owner. Such infected bees, hives, honey and appliances shall be deemed a public nuisance.

Section 1165-2. For the purposes of this act the director of agriculture is given full authority to establish and maintain quarantines prohibiting the shipment into or within the state, or any subdivision thereof of any bees, queen bees, used hives or any part thereof, used appliances or any material capable of transmitting any bee diseases, for such periods and under such conditions as he may deem necessary to control, eradicate or prevent the introduction, spread, or dissemination of any and all bee diseases, giving such notice thereof as may be prescribed by the director of agriculture, and during the existence of such order no person shall remove or ship from such area any such material whatever except by special permission or order of the director of agriculture; provided, however, that before the director of agriculture shall promulgate the order of quarantine as provided in this section, the director of agriculture shall, after due notice to interested persons, give a public hearing under such rules and regulations as the director shall prescribe, at which hearing any interested person may appear and be heard, either in person or by attorney.

Sec. 1165-3. County commissioners of the several counties shall have and are hereby given authority to appropriate such funds as they may deem sufficient for the inspection of apiaries in their counties. They shall have authority to appoint a deputy apiarist with the consent and concurrence of the director of agriculture, said deputy apiarist to serve during the pleasure of said board of commissioners except as hereinafter specified. Such county deputy apiarist shall be paid a per diem of five dollars for each day, or two dollars and fifty cents for each half day of inspection work actually done, together with such expenses as may necessarily be incurred in the doing of the inspection work. However, before the said county commissioners shall approve said salary and expenses for payment, such deputy apiarist shall submit the same to the director of agriculture for his approval. Such deputy apiarist shall work under the direction of the director of agriculture and shall be responsible to him for the enforcement of the laws relative to the keeping of bees and treatment of disease. The director of agriculture shall have the authority to terminate the appointment of any deputy apiarist upon submitting to the county commissioners a statement that such deputy apiarist has shown himself to be incompetent, inefficient or untrustworthy in the discharge of his duties. Such deputy apiarist shall furnish to the director of agriculture such reports as shall be required and upon blanks furnished by him. A duplicate of such reports shall be presented to the county commissioners at each time that a statement of salary and expense is presented for payment.

Section 1166. (1) Any person in interest or affected by any order of the director of agriculture, or state apiarists may appeal therefrom to the director of agriculture of Ohio within five days of the service of such order upon him setting forth in writing specifically and in full detail the order on which a hearing is desired, and every reason why such order is deemed unreasonable.

(2) On receipt of such appeal the director of agriculture of Ohio shall with reasonable promptness order a hearing thereon and consider and determine the matters in question. Notice of the time and place of hearing shall be given to the petitioner and to such other persons as the director of agriculture of Ohio may direct. Such appeal shall suspend the operation of the order appealed from except as to the orders of the director of agriculture promulgating a quarantine as provided in section 5 hereof. All hearings of the director of agriculture of Ohio shall be open to the public, and his decisions shall be final. The appellant shall have the right to be represented by an attorney.

Section 1167. All persons within the state of Ohio engaged in the rearing of queen bees for sale or gift, shall before April 1 of each year file with the director of agriculture a request for the inspection of his apiary or apiaries in which queen bees are reared. The director of agriculture shall cause all queen apiaries to be inspected at least once each year. If such inspection shall show the presence of any bee disease in any queen apiary the owner thereof shall not ship, sell, or give away any queen bee until he shall have destroyed such infec-

tion to the entire satisfaction of the director of agriculture. When such infection shall have been removed from the infected queen apiary or in the event of no infection being found, the director of agriculture shall issue a certificate, signed by the state apiarist, a copy of which shall be attached to each package or shipment of queen bees mailed or shipped. Such certificate shall be valid for not to exceed one year. The use of tags or other devices bearing an invalid or altered certificate and the misuse of any valid certificate is hereby prohibited.

Section 1168. The director of agriculture shall have the power at all times to revoke any certificate for cause, including any violation of this act, or nonconformity with any rule or order promulgated under this act.

Section 1168-1. For the purpose of this act the director of agriculture or his duly authorized representatives shall have access and egress to any apiary or any premises, buildings, or any other place, public or private, in which he has reason to believe that bees, honey, wax, used hives or used appliances are kept, and any and all persons who shall resist, or hinder the director of agriculture or his duly authorized representative in the discharge of his duties under the provisions of this act shall be guilty of a violation of this act, provided, however, that no occupied dwelling may be entered without a search warrant.

Section 1168-2. The director of agriculture shall have authority to publish an annual report and such other information concerning the inspection of bees, or bee diseases as he may deem necessary to the carrying out of the provisions of this act. He shall also, from time to time, publish all rules or orders promulgated under the terms of this act.

Section 1169. Any person violating any of the provisions of this act or any rule or order of the director of agriculture promulgated under this act shall be, on conviction, fined not more than five hundred dollars.

Section 1169-1. The probate court of any county shall have original jurisdiction in prosecutions under the provisions of this act of violation occurring within that county. Such court shall be open at all times for such purposes regardless of the terms fixed therein for the trial of criminal cases, and the complainant shall not be required to give security for costs. The prosecuting attorney of each county, or the attorney general, shall conduct such prosecutions, and fines recovered shall be paid to the director of agriculture.

Section 1169-2. Oiginal sections 1164, 1165, 1166, 1167, 1168 and 1169 of the General Code be, and the same are hereby repealed.

It will be noted in Sec. 1165-3 of the Ohio law that county commissioners may appropriate funds for the inspection of apiaries in their respective counties, and that they can appoint a deputy apiarist at five dollars a day with the concurrence of the state. This gives the state apiarist or bee inspector authority to supervise the work and to co-operate and work with the deputy county bee inspector.

This plan has been working very satisfactorily for several years in Ohio. It places part of the responsibility and the expense on the county where the work is to be done. In counties where there are many apiaries or much disease more funds can be made available by local beekeepers bringing pressure on their county commissioners than could be secured if the entire amount were to come from the state as a whole with a limited appropriation.

The further advantage of the state-county system is that when the state is low on funds as it was in 1933 and 1934 in Ohio, the counties, according to their needs, can to a large extent make up for the deficiency.

The author strongly urges the kind of law that Ohio has. It too often happens that the State Legislature fails to appropriate sufficient funds to carry on the work of bee inspection in the state. Without the assistance of the counties the work would be seriously crippled if not stopped altogether.

LAYING WORKERS.—Laying workers are usually the result of neglect or poor beekeeping. These queer inmates, or, rather, occasional inmates, of the hive are worker bees that lay eggs, and the eggs hatch, too! The remarkable thing is that they hatch only drones, and never worker bees. The drones are somewhat smaller than the drones produced by a queen, but they are nevertheless drones in every respect, so far as is known. It may be well to explain that ordinary worker bees are not neuters, as they are sometimes called, but undeveloped females. Microscopic examination shows an undeveloped form of the special organs found in the queen, and these organs may at any time become sufficiently developed in worker bees to allow them to lay eggs, but never to allow for fertilization by meeting the drone as the queen does. (See Parthenogensis, Dzierzon Theory, and Queens.)

Cause of Laying Workers

It is now pretty generally conceded that laying workers may make their appearance in any colony or nucleus that has been many days queenless and without the means of rearing a queen. In the case of Cyprians, Holy Lands, or Syrians and their crosses, laying workers are common.

Not only may one bee take these duties, but there may be many of them; and wherever the beekeeper has been so careless as to leave his bees destitute of either brood or queen for two or three weeks he is almost sure to find evidences of their presence in the shape of eggs scattered about promiscuously, sometimes one but oftener half a dozen in a single cell.

Sometimes the eggs will be found stuck on the sides of the cell. In that case it

is evident the laying worker can not reach the bottom of the cell. Very often several eggs will be found in a queen-cell.

If the matter has been going on for some time, one will see now and then a drone larva, and sometimes two or three crowding each other in their single cell. Sometimes bees start queen-cells over this drone larva. The poor motherless orphans, seeming to feel that something is wrong, are disposed, like a drowning man, to catch any straw.

How to Get Rid of Laying Workers

Prevention is better than cure. If a colony, from any cause, becomes queenless, give it a laying queen, a virgin or unsealed brood of the proper age to raise a queen; and when one is raised, see that she becomes fertile. It can never do any harm to give a queenless colony eggs and brood, and it may be the saving of it. But suppose one has been so careless as to allow a colony to become queenless and get weak—what is he to do? If he attempts to give them a queen, and laying workers are present, she will be pretty sure to be killed; it is sometimes difficult to get them to accept even a queen-cell. The poor bees get into a habit of accepting the egg-laying workers as a queen, and they will have none other until they are removed; yet they can not be found, for they are just like any other bee; one may get hold of them, possibly, by carefully noticing the way in which the other bees deport themselves toward them, or one may catch them in the act of egg-laying; but even this often fails, for there may be several such in the hive at once. A strip of comb containing eggs and brood may be given them, but they will seldom start a good queen-cell, if they start any at all; for, in the majority of cases, a colony having laying workers seems perfectly demoralized, so far as getting into regular work is concerned.

It is practically impossible to introduce a laying queen to such colonies; for as soon as she is released from the cage she may be stung to death. No better results would follow from introducing an ordinary virgin; but the giving of a queen-cell, or a just-emerged virgin, if the colony has not been too long harboring laying workers, will very often bring about a change for the better. In such cases the cell will be accepted, and in due course of time there will be a laying queen in place of the laying worker or workers; but often cells will be destroyed as fast as they are given.

When this happens scatter brood and bees among several other colonies, perhaps one or two frames in each. From each of these same colonies take a frame or two of brood with adhering bees, and put them into the laying-worker hive. The original bees of this hive, which have been scattered into several hives, will for the most part return; but the laying worker or workers will remain and in all probability be destroyed in the other hives. Of course, the colonies that have been robbed of good brood will suffer somewhat; but if it is after the honey season no great harm will be done. They will proceed to clean up the combs; and if they do not need the drones they will destroy them.

Still another plan, and perhaps the best, is to destroy the bees outright.

How to Detect the Presence of Laying Workers

If no queen is found and eggs are scattered around promiscuously, some in drone and some in worker cells, some attached to the side of the cell, instead of the center of the bottom, where the queen lays them, several in one cell and none in the next, it may be assumed that laying workers are present. Still later, if the worker-brood is capped with the high convex cappings, it indicates clearly drone brood. Finding two or more eggs in a cell is never conclusive, for the queen often so deposits them in a weak colony where there are not bees enough to cover the brood. The eggs deposited by a fertile queen are usually in regular order, as one would plant a field of corn; but those from laying workers, and usually from drone-laying queens, are irregularly scattered about.

LEVULOSE.—See Honey, Honey Candy, Honey Cooking, Value of, and Honey, Science of.

LIME.—See Sweet Clover and Clover.

LIMA BEAN (*Phaseolus lunatus.*)—Seventy-five per cent of all the beans harvested in the United States are grown in California, and more than 50 per cent of the entire crop comes from the southwestern counties of Ventura, Orange, Santa Barbara, and San Diego. Of the various varieties of beans raised in California only the Lima bean is of value to the bee-

keeper, although the black-eyed bean has been erroneously stated to yield an amber-colored honey.

The Lima bean is adapted to a coastal strip 20 miles in width, extending from Santa Barbara County southward to San Diego County, which is subject to heavy ocean fogs. Cool sea fogs and the absence of protracted hot spells are required for the maturing of the plant, otherwise it is apt to blight; but the dense fogs often retard the flight of bees.

A bush variety of the Lima bean has been very extensively planted during the past few years. It is grown a little farther away from the ocean and is irrigated. In 1920 thousands of acres of this bean were planted in the San Fernando Valley, which was the haven of many a migratory beekeeper. Nectar was secreted in abundance by irrigated bush-Lima bean fields, while bees dependent on the older variety of pole Limas were starving. The vines bloom in July and August and yield a heavy, white, mild honey which has an agreeable flavor. Most of the honey is secured during the first two weeks of bloom. It granulates quickly. The honey crop from this source is rather uncertain as it is influenced by weather conditions. If there are many days of hot sunshine little nectar is secreted and too much fog prevents the flight of the bees.

LINDEN.—See Basswood.

LIVE-BEE DEMONSTRATION. — See Honey Exhibits.

LOCALITY.—Many of the manipulations recommended for one locality will not answer for another. The same colony under different conditions may give very different results. The length of the flow and the time it begins must receive careful consideration. If the honey flow is short and rapid, as in the white clover regions where the honey is mainly white, it is, as a rule, more profitable to produce comb honey than extracted honey. But a slow honey flow extending over three or four months may render the production of comb honey impracticable since the combs will be travel-stained and will not command the highest market price.

Locality also exerts a great influence on the treatment the bees should receive. If no honey is stored after the middle of July and the beekeeper lives in a state where snow falls in winter and cold weather prevails for five or six months, he will put on his food-chamber early. (See Food-Chambers.) If, however, he has a fall flow he may not be compelled to do this until later. If the beekeeper is located in the South the bees will require a much larger amount of stores than in the North, for in a warm climate the bees are more active and consume more honey in brood-rearing. The bees in the northern states are likely to perish from cold; in the southern states from starvation. It is then that a full-depth food-chamber will be required.

Some localities are so cold that only cellar wintering is practicable. (See Wintering in Cellars.) South of these extremely cold places outdoor wintering in double-walled hives or packing cases is preferable.

Some regions of the country are favorable for the propagation of European foulbrood mainly for the want of early flows to build up the colonies in the spring.

Many inquiries have been received as to the best locations for beekeeping. So many factors enter into this question that a satisfactory reply is difficult to give, and often the beekeeper can remain at home to advantage. The value of a locality depends on the personality and methods of the beekeeper, as well as on the honey flora. "The poor quality reported for many regions," says Phillips, "is probably due to poor beekeeping. In many sections adequate trials of commercial beekeeping have not been made. The prevalence of foulbrood is not a serious drawback to a good beekeeper."

The Best Beekeeping Localities

Beekeeping is only moderately successful in New England, but the bee pasturage of this section might be greatly improved by more commonly planting alsike clover and sweet clover, where there is sufficient lime in the soil. Excellent results have been obtained in the Champlain Valley, Vermont, where there are limestone soils and the surplus comes from white, alsike, and sweet clover. Other good locations are Aroostook County, Maine, the Berkshire Valley, Massachusetts, and portions of central Connecticut.

In the production of honey New York leads the eastern states. On the glacial till soils of St. Lawrence and Jefferson

counties the clovers yield an immense amount of white honey. A second white clover belt extends from Buffalo to the Hudson River, which includes a large number of apiaries located among the Finger Lakes, Cayuga County, and around Syracuse, Onondaga County. The southern portion of the state, especially the southwest corner, is the great buckwheat country, where this plant is usually a reliable source of honey. Another important center for bee culture is found in the eastern part of the state in Schenectady County, where the clovers, buckwheat, and basswood are abundant.

Southeastern Pennsylvania is in a very high state of cultivation and few follow beekeeping as a vocation. Along the north-central border and in the northwest corner thousands of acres of buckwheat are grown. Within the mountains there are many fertile valleys with limestone floors, where the clovers flourish and yield well. Southwestern Pennsylvania, the region of the great steel mills and oil fields, affords little pasturage for bees. New Jersey, Delaware, and Maryland, on account of the lack of lime in the soil, are not considered beekeeping states from a commercial point of view and the average surplus per colony is low.

Throughout the southern states many of the colonies are still in "gums," but beekeepers are transferring into modern hives very rapidly. The number of colonies per square mile is greater here than elsewhere in the country, which indicates good beekeeping conditions. "The solution of the problem in the South, "says Phillips, "lies in the development of a few extensive beekeepers relatively who will practice migratory beekeeping. If the difficulties of transportation can be overcome the South can produce enormous crops of honey." In the southeastern states the honey crop comes chiefly from the swamps or from the mountains, and in both locations the honey plants are mostly shrubs and trees. Much of the soil is acid and white clover is found only to a limited extent. In its stead we find gallberry, tupelo, and titi.

The pine barrens of eastern Virginia offer little opportunity for bee culture. A good locality is the section of the Piedmont Plateau east of the Blue Ridge. In the Great Limestone Valley west of this range of mountains and in the smaller limestone valleys in the southwest portion of the state the area of sweet clover and white clover is yearly increasing. There is, however, little commercial honey production in Virginia. Beekeeping in Kentucky is most prosperous in the famous blue grass region or the Lexington Plain. It is a limestone area. The Coastal Plain of North Carolina, with its vast area of swampland covered with gallberry, gum trees, huckleberry, and blackberry, offers great opportunities to the specialist. The cotton belt is the poorest part of the state for beekeeping. Sourwood and tulip tree yield a large surplus in the western highlands and mountains. Beekeeping is in a very undeveloped condition in South Carolina. More than 10,000,000 acres of pine barrens are largely destitute of honey plants.

In southeastern Georgia, where the gallberry and tupelos are abundant, the honey crop is usually reliable, and a surplus of 100 pounds per colony is often obtained. There is little commercial beekeeping in northern Georgia. Considerable honey comes from the black and white tupelos growing in the swamps of the Apalachicola River in northern Florida.

Good crops of honey are often obtained in central and southern Florida from orange, summer farewell, and palmetto, and black mangrove in some seasons yields well in the southwestern part of the state. Migratory beekeeping is found to be fairly profitable on the Keys. (See Migratory Beekeeping.)

The Black Belt

In Alabama and Mississippi the best section for table honey is the Black Belt, or sweet clover belt, a tract of land which extends from Union Springs, Alabama, to Noxubee County, Mississippi, where it follows the state line northward to Tennessee. Thousands of acres of sweet clover flourish in this section, and the apiaries, which range from 50 to 200 colonies, are much larger than in other parts of the state. In the Yazoo Delta are the most fertile soils in Mississippi and a more dense acreage of cotton can not be found elsewhere in the South; but none of the honey plants are of great value except holly, without which, declares a beekeeper, it would not pay to keep bees. Fair opportunities for beekeeping may be found near the swamps and in most of the river valleys of both Alabama and Mississippi.

The Alluvial Tracts

In Louisiana the alluvial tracts along the Red and Mississippi rivers and the Atchafalaya River Basin are as well adapted for honey production as any portion of the southern states. It is in these sections that white clover has taken such a strong hold. It grows here more luxuriantly than in the North and yields some honey but not as much as from the same acreage in the North. The southeast half of Arkansas belongs to the Coastal Plain, and, as the honey flora of the lowlands is dependable, it offers excellent opportunities for engaging in beekeeping on a commercial scale. A thorny chaparral of Mexican origin covers the Rio Grande Plain in southeastern Texas. Huajilla, catsclaw, mesquite, and a score of other shrubs yield nectar so copiously that in a favorable season it is almost impossible to overstock this region with bees. On the Black Prairie, which extends from San Antonio to the north border line, cotton is a reliable honey plant, and seldom fails to yield a large surplus. West of the Pecos River agriculture is dependent upon irrigation, and alfalfa is the main dependence of several large honey producers.

Bitterweed Honey and Its Importance in the South

In Alabama and Mississippi, with the exception of the Black Belt region, much of the honey is dark and off-flavored, especially that from bitterweed, which is so poor that it is unfit for human consumption. But bitterweed comes on at a time and over a period that makes it invaluable for the raising of package bees. (See Package Bees.) The general distribution of bitterweed makes central Alabama lead in the production of package bees. It is perhaps not too much to say that more package bees are raised for the North within 50 or 75 miles of Montgomery than in any other equal area in the United States. This would not be possible were it not for the bitterweed honey that is held over in the hives from the previous fall and used the following spring for heavy brood-rearing, without which bees could not be raised in early April and May for the northern beekeeper. The value of a large amount of stores in the fall is explained under Food-chamber.

White Clover and Its Distribution

In no part of the United States are the soils and weather conditions better adapted for the growth of white clover than in northwestern Ohio, eastern Indiana, southern Michigan, southern Wisconsin, southern Minnesota, northern Illinois, and in Louisiana along the rivers. In the Upper Peninsula of Michigan alsike clover is very abundant and thousands of acres of unoccupied territory invite the beekeeper. In southwestern Indiana large crops of honey are stored from climbing milkweed, and in the northwestern corner Spanish needles and boneset in the Kankakee swamps are valuable in the fall. White clover, sweet clover, and heartsease are so common in Stephenson County that no other portion of northwestern Illinois produces so large a surplus of honey. On the Mississippi River, where there is a wide valley, Spanish needles, heartsease, and boneset assure a dependable fall flow. Northern Wisconsin is at present only partially developed, but the pioneer beekeeper will find it one of the most promising sections in the United States.

In Iowa there are two sweet clover regions, one in the eastern part of the state, especially in Jackson County, and the other in the western part of the state along the Missouri River extending southward from Sioux City. Good results may be expected in almost every county in this state. The majority of successful beekeepers in Missouri are located near the Missouri and Mississippi rivers and their tributaries, but there are not many commercial beekeepers in this state. When white clover fails on the uplands, a crop may be obtained from the fall flowers along the rivers.

Alfalfa and Sweet Clover

Throughout the western states semi-arid conditions prevail, except in the rain belt west of the Cascade Range, and commercial beekeeping is dependent almost entirely on irrigated alfalfa and sweet clover. The sweet clover pasturage in eastern North Dakota is promising. In South Dakota there is a large area of sweet clover in the southeastern counties, and in the Black Hills there are thousands of acres of irrigated alfalfa. The Belle Fourche Valley is an ideal farming region. Where alfalfa is grown without irrigation in Nebraska the yield varies greatly in different sections and in different years. It is most reliable in the valley of the Platte River, which crosses the state from west to east. In Kansas

likewise alfalfa and sweet clover in many portions of the state is an uncertain honey plant, but it is most dependable on all streams west of Topeka. Good locations in Oklahoma are found along the larger streams, as the Canadian and Washita Rivers. In Nebraska, Kansas, and Oklahoma the future of beekeeping will depend largely on the increase of the sweet clover acreage, which is now coming on very rapidly.

The largest surplus of honey in Montana comes from the irrigated lands along the Yellowstone River and from Ravalli County in the Rocky Mountains. Probably in no state in the union are larger crops of honey produced than in northern and southeastern Wyoming. In the Great Plains of Colorado bee culture is profitable only in the valleys of the South Platte and Arkansas rivers. There are few bees in the Rocky Mountains, but on the western slope irrigated alfalfa and sweet clover along the irrigating ditches seldom fail to yield a bountiful harvest. Bee culture in New Mexico is restricted mainly to the valleys of the Rio Grande, Pecos, and San Juan rivers.

At Sandpoint in northern Idaho white clover, buckbush, and fireweed are excellent sources of honey. In southern Idaho the best locations are the irrigated alfalfa fields in the Boise Valley and in the vicinity of Twin Falls. Most of the beekeepers of Utah are found in the Uintah Basin and the mountainous tract extending through the central portion of the state. Nevada is largely a desert, but the western counties produce the finest and whitest alfalfa honey. The Salt River Valley of Arizona was for many years a famous country for beekeeping, but during the World War the great fields of alfalfa were ploughed and seeded with long-staple Egyptian cotton, which is largely used in the manufacture of automobile tires.

For the distribution and the acreage in each state, see Sweet Clover.

The Pacific States

Commercial beekeeping in Washington and Oregon is confined wholly to the irrigated areas west of the Cascade Range. In the Yakima Valley, Washington, and in Umatilla County, Oregon, irrigated alfalfa is the chief honey plant. In the lumbered regions of the Coast Range, where there is a heavy rainfall, fireweed offers wonderful possibilities, but the colonies require special management and the nectar flow is not always reliable.

California Beekeeping

California in some years leads all the states of the Union in the total amount of honey produced. The most important honey plants are orange, the white, black, and purple sages, Lima bean, and alfalfa. The secretion of nectar is largely dependent on irrigation, rainfall, and fog. Alfalfa is the chief source of surplus in the Central Valley, but star thistle is very important northward. In the southwestern counties of Santa Barbara, Ventura, Los Angeles, Riverside, San Bernardino, Orange, and San Diego most of the commercial beekeepers are located. Migratory beekeeping is extensively practiced. The home apiary is usually located in the foothills near the orange groves. After the flow from orange bloom is over it is moved to the sage ranges, then to the bean fields, and perhaps later to wild buckwheat. Within 150 miles of Los Angeles there are more bees and beekeepers than in any other part of the United States, and 10 per cent of them are located in the sage ranges. Two difficulties in southern California are the variability of the seasons and the prevalence of bee diseases, both the American and European foulbrood. The bees breed almost every month in the year and of course the brood diseases can continue for ten or eleven months. It takes good beekeeping to overcome this, and the tendency is for the queens to wear out, leaving the colonies with insufficient brood at a time of the year when it is most needed to insure a force of bees for the orange. In the Imperial Valley the surplus flow comes almost wholly from irrigated alfalfa and cotton. A fair average is 75 pounds per colony and it is seldom that the crop is a failure. Few bee ranges are unoccupied and no one should migrate to this section without first investigating.

The North and the South

In a general way it may be said that the yields per colony in the North are larger than in the South. Moreover the higher the altitude and farther north one goes, the better the quality of honey and the larger the average yields.

For an exhaustive discussion of this subject state by state, see "Honey Plants of North America," Part IV. The reading of this will more than repay the price.

LOCUST (*Robinia Pseudo-Acacia.*)—Variously called common locust, black locust, white locust, yellow locust, false Acacia, pea flower, locust, post locust, and locust tree. This is one of the finest honey trees of the eastern and southern states. It belongs to the great family of the Leguminosae, which includes many of the best honey plants, as the clovers, sainfoin, red bud, honey locust, sweet clover, and huajilla. It is a native of the mountains from Pennsylvania to Georgia, and westward to Missouri and Arkansas, but has become extensively naturalized in Canada, New England, and the eastern states. Large plantations of it have been made for timber. The wood is hard and very durable, and is much used for posts. There is a saying that stone will crumble before locust will rot. The tree grows to medium size, and is long-lived except when attacked by borers. It spreads rapidly by sprouts rising from the roots, which run under ground for long distances near the surface. When the trees are cut or killed by borers the roots send up a great many sprouts, which grow very rapidly and flower, within two or three years.

The white, very fragrant flowers are similar in form to the blossoms of the garden pea, but are in pendent clusters like those of wistaria. They appear in May or June, and the blooming period last for about 10 days. Under favorable conditions a large amount of milk-white honey of heavy body and mild flavor is secured, but it is not a reliable honey plant and does not bloom every season. See "Honey Plants of North America."

LOG GUM.—See Box Hives, also Transferring.

M

MANGROVE, BLACK (*Avicennia nitida*).—There are in southern Florida three different trees called mangrove, the red mangrove, the white mangrove, and the black mangrove, but only the last-named is important to the beekeeper. It grows on the seashore of southern Florida, the Keys, and eastern Texas, also in tropical America. In Florida it is not found to much extent north of Ormond on the east coast. It usually grows back of the red mangrove, and in localities where both grow together the red mangrove fringes the shore and makes new land. But black mangrove is the honey plant.

The black mangrove, when it grows to the size of a tree, resembles a scraggly old oak with a rough brown bark. It may be 25 to 50 feet tall, with a trunk diameter of four feet, or on the Keys it may attain even greater size. Northward it is seldom more than a shrub. The leaves are leathery, oblong, with very short stems, and when they unfold are somewhat hairy, but later become bright green and shining above, paler or nearly white beneath. The flowers are small, inconspicuous, in terminal clusters, appearing at all seasons of the year. The wood is dark brown and very durable in contact with the soil. When used as fuel it burns with intense heat.

Up to the year of the "big freeze," in 1894, phenomenal yields were reported. As much as 400 pounds of honey from one hive in a single season have been recorded. But the severe winter of 1894 froze and killed the mangrove to the ground. It did not recover from this check for 18 years, and not until 1909 did it again yield nectar, and then only in small quantities. Since that year the bushes have gradually grown in size and the yields have increased also.

MANIPULATION OF COLONIES.—Under the head of Anger of Bees and under Stings it is shown that bees are not the irascible little creatures that many people suppose; that they are, on the contrary, when their nature is carefully studied, as gentle as kittens; and when one goes about it in the right way, they can be handled almost as safely.

(See A B C of Beekeeping at the beginning of this work.) But one can not thoroughly know this until he has actually opened the hive or seen it opened and actually handled the combs for himself. This is not saying bees will not sting when handled improperly or at the wrong time.

The beginner should understand that bees can be worked very much better when weather conditions are right. The day should be warm, the sun shining, and the time selected for the manipulation between ten in the morning and three in the afternoon. Experienced beekeepers can handle them at any time under practically all conditions; but even the veterans endeavor to do it when they can work to the best advantage. In early spring or late in the fall, or when the atmosphere is chilly, or at any time immediately following a rain, or after a sudden stoppage of the honey flow, bees are inclined to be cross. When it is cold, the bee glue in the hives is brittle. In order to open a hive at such times it is necessary to break this bee glue with a snap or jar. This always has a tendency to irritate the bees, even when weather conditions are favorable. The beginner at least should select his time, and of course will endeavor to make his movements very deliberate, avoiding quick jerky movements, all snaps or jars. There are times when one will be compelled to open hives when the bee glue snaps and when the bees sting; but if a beginner, he should await a more favorable time.

Tools for Bee Work

Before details of manipulations are considered, it will be necessary to take up tools and conveniences, without which the handling of colonies would be difficult or even impossible at times. There are several essentials which may be mentioned in the order of their importance: A bee-smoker (see Smokers) for quieting the bees; a bee-veil (see Veils), and suitable clothing for protection against stings, and some form of knife, screwdriver, or hive-tool to separate the frames and parts of the hive stuck together with bee glue. Without the smoker and its intelligent use one would feel almost inclined to go back to the days of our forefathers when they brimstoned their bees (see Box Hives). But with smoke properly applied, one can render bees tractable that would be otherwise nervous and hard to handle. Even when conditions are bad, weather chilly and propolis hard, they can generally be brought under control. The intelligent use of the smoker will often render the use of the veil unnecessary; and not a few experienced beekeepers do not use a veil constantly, but have it conveniently hanging from the hat, whence it can be pulled down, whenever necessary. A bee-veil, however, is generally worn by veterans and beginners alike all the time while at work among bees. It is annoying and disconcerting to have cross bees buzzing around the face with the possibility of a sting in the eye, nose, or mouth. The beginner will always have a greater sense of security when his face is protected, and the veteran works with less interruption.

Gloves (see Gloves) are recommended to the novice when he opens a hive for the first time. After he has learned the habits of bees he may dispense with them, because he will at most receive only an occasional sting on the hand. Very often

Bee-gloves.

experienced beekeepers wear a long gauntlet that reaches from the elbow to the wrist. This should be made so that no bees can get up the sleeve. It should fit tightly around the wrist or, better

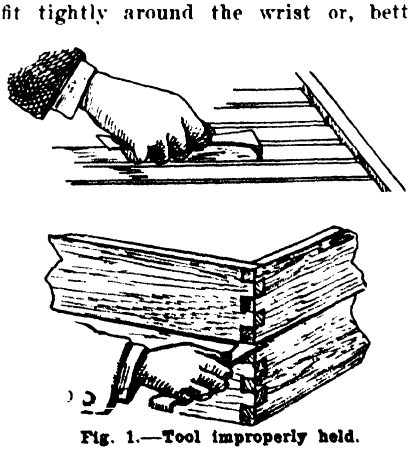


Fig. 1.—Tool improperly held.

Fig. 2.—A side twist of the tool affords a strong leverage by which the frames are separated easily and without jar.

Fig. 3.—Another method of using a hive-tool when prying frames apart.

Fig. 4.—The proper way to pry all the frames over at one operation.

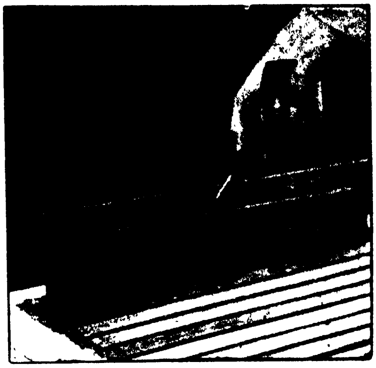
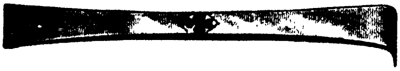


Fig. 5.—How the hook end is useful in fishing out frames and division-boards.

yet, reach far enough to cover the hand, leaving the ends of the fingers exposed.

For certain seasons of the year when weather conditions are unfavorable, such gloves are a great convenience, if not indispensible for the veteran beekeepers. To go without them often means a lot of unnecessary punishment.

While ordinary overalls may be used, a specially designed union bee suit, tight fitting at the neck, wrists and ankles is far better. It should be made of white duck cloth, because white is cool and because it is more acceptable to the bees.



Hive tool.

If bees are to be shaken from the combs as in extracting, the bottom of the trousers or suit should be tucked in the socks or folded tight around the ankles and held with a string or bicycle pants guards.

In the line of tools a common jackknife or a common screwdriver may often be used in lieu of something better. But a hive-tool made for the purpose is far superior.

The illustrations opposite and above show a form of tool that is almost universal among beekeepers. The V-shaped hole in the center is for pulling tacks or nails.

The hooked end is ordinarily used for scraping propolis or wax from the frames or bottom-boards, while the other end (also useful for scraping) is pushed between the two parts of the hive. The drawing (Fig. 1) shows the tool held improperly. The bent or curved end should be placed directly against the palm in order that sufficient pressure may be exerted to shove the other or straight end between the two hive parts.

Either end of the tool may be used for separating Hoffman frames, or, in fact, any style of frame that one happens to use; but the author prefers the hook end. This is inserted between the frames to be separated, as shown in Fig. 2, when a side twist will exert considerable leverage, forcing apart the frames very gently. However, there are some who prefer

Fig. 6.—Making a gap between the frames so that one can be easily removed.

to use the straight end of the tool in the manner shown in Fig. 3; but the method given in Fig. 2 exerts more of a leverage, and, at the same time, is less liable to crush bees.

Fig. 4 shows how the tool may be used for crowding all the frames over to one side in one block; or one can, if he prefers, use the plan shown in Fig. 2; but it will generally be found that the one shown in Fig. 4 is more convenient. In Fig. 5, the curved end is used to good advantage in lifting the division-board out of the hive.

Super tongs.

Some prefer a hive-tool having a narrowed end like a screwdriver; but the continuous use of a tool like this abrases the edges of the hive so that, after a time, it leaves bruise marks and cracks, inviting winds and storms, and robbers when they are prowling about. For separating two hives heavy with honey the best tool is the super tongs. By its use, through the principle of leverage, the super can be shoved forward without snap and brasing the edges of the super or hives. See cut bottom of the page, first column.

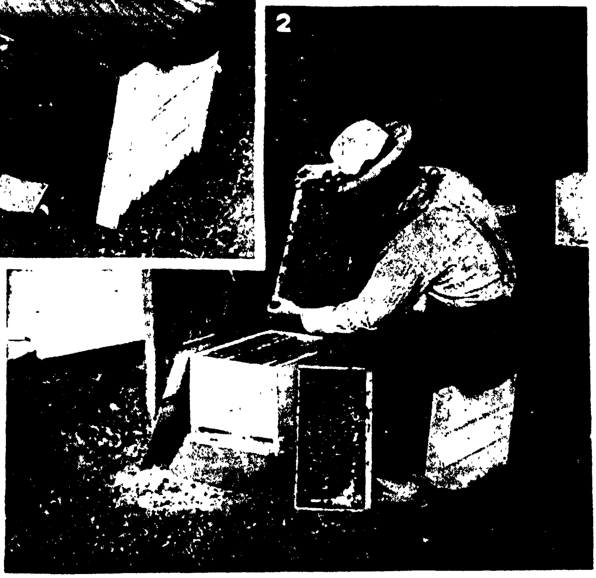
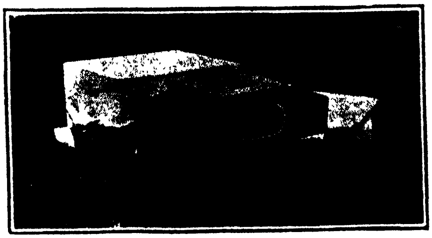


Fig. 7.—A comfortable position for an all-day work. Note that the left arm that supports the weight of the frames rests comfortably on the knee.

How to Work Over Hives

Many yard men prefer to work with a sort of stool and hive box combined; yet others wish to have nothing to lug around except the bee-smoker and the hive-tool. As most hives are placed on or near the ground, one must either sit



The exact dimensions of the seat are not important. The one shown here is 13 inches high by 22 long, ouside measurements.

down on some object or kneel beside the hive, to bring himself to the proper working distance. Many use a hive-cover as shown in Figs. 6, 7 and 8. It is always handy and has the further advantage of a milk-stool in that one can shift his body back and forth on the hive-cover in order to reach frames toward the near or far side of the hive, as the case may be. A seat that does not allow one to shift his body back and forth, necessarily requires more stooping or bending of the back.

Occasionally it will be found desirable to turn the cover up lengthwise, and the author always uses it in that manner when he desires to place the weight of the body against the frame that is crowding over against its fellows. (See Fig. 8.) But if he merely wishes to separate the frames, then spend several minutes hunting for the queen or looking over the brood, as shown in Fig. 7, he should sit on the narrow side rather than on the end. In this the operator assumes a very natural, easy, and comfortable position. The left arm rests upon the knee, supporting the weight of the frame, while the right arm holds it in a position for examination.

Fig. 8.—A higher seat is better when one wishes to place his weight against the frame to be shoved over.

A change of position is often restful. After one has been working over a number of hives, sitting down on the hive-cover, he finds it convenient to vary the position by resting on the knees close to the hives; and still again he may find it comfortable to vary the monotony by standing upright, bending over only when it is necessary to remove a frame.

Some of our apiarists will say they have no time to sit down, much less to "loaf on the job," as might appear in Fig. 6. The more one can save his legs and arms the more he can actually accomplish in a day. In hunting for a queen one can not afford to stand up on the job, but should get right down where

Fig. 10.—Method of inserting the hive-tool under the cover; blowing smoke into the gap thus made.

the eyes can do their best work, as seen in Fig. 7, always holding the frame in such a way that the sunlight will strike it squarely. In looking for eggs this is very important, especially if the operator is getting old when eyesight is not at its best.

Where one is working over bees day after day, a special hive-seat is a great convenience.

How to Open a Hive

For general directions on how to open a hive the reader is referred to pages 9 and 10 of this work.

How to Handle Unspaced Frames

To get at the center frame, crowd the frames adjacent to it, one at a time, toward the sides of the hive. This will give room to lift out the desired frame. Beginners are very apt to pull the frames out without spacing the frames apart. This rolls the bees over and over, enrages and maims them, and moreover runs a pretty good chance of killing the queen. Lift the frame out carefully, and be careful not to knock the end-bars against the ends of the hive. If it is one's first experience he may be nervous, and do things a little hurriedly. As a reward, the bees will quite likely sting him and make him still more nervous. To avoid this, proceed very cautiously and make the movements deliberate. Having removed the frame, hold it up as shown in Fig. 1, called the first position.

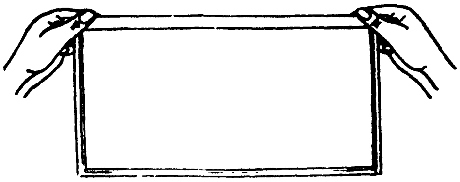
How to Find the Queen

Perhaps the queen is not to be seen on this side, so it may be necessary to turn it over and see the other side. If the comb is not heavy with honey, it can be turned right over with the bottom-bar resting horizontally. But if the comb is heavy and unwired raise the right hand until the top-bar is perpendicular as in Fig. 2.

Now revolve the frame like a swinging door or the leaf of a book, so that the opposite side is exposed to view (see Fig. 3). Lower the right hand as in Fig. 3 until it reaches the position as shown in Fig. 4. To examine the other side follow the exact reverse order. This procedure, 1, 2, and 3, will not be necessary if the combs are well wired. (See Wiring Frames under Comb Foundation.)

Having examined this frame, lean it up against the side of the hive, and remove another frame next to the one already taken. Examine this in like manner. Lean this also against one corner of the hive, or return it to its place; lift out another, and so on until all have been examined. Should the queen not yet have been found, look the frames all over again, being careful to examine the bottom edges of the combs. (See How to Manipulate Hoffman Frames.)

If the queen is not found on the second examination it may be advisable to go over the frames once more; but very often it is better to close the hive and wait an hour, or two, after which one can go back and search the frames as before.



1.—First position of frame.

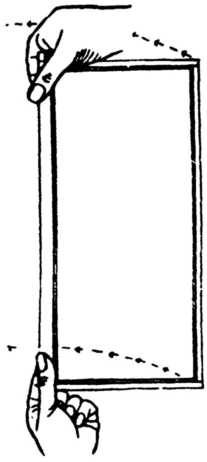


Fig. 2.—Second position. Arrow shows direction in which the frame is now to be turned.

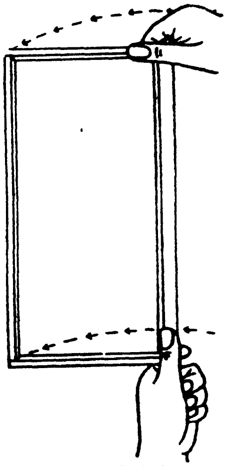


Fig. 3.—Third position. Arrows show direction from which the frame has just been turned.

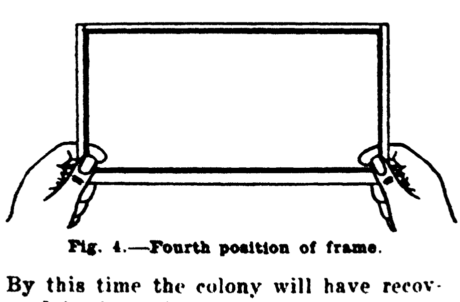


Fig. 4.—Fourth position of frame.

By this time the colony will have recovered itself, and the queen, in all probability, have shifted her position from the bottom or sides of the hive to one of the combs. In most cases she will be found at the second going-over of the frames without any trouble. When the queen can not be found the second time going over, as a rule hunting longer is not advisable because one is liable to waste a good deal

of valuable time. It is then better to wait till the queen comes out of her hiding-place back to the brood-frames themselves. If the bees are inclined to rob, use an empty body to hang half of the frames in, placing them in pairs, and pair off the rest in the hive being worked.

In the case of black colonies, especially where very populous, it is sometimes necessary to lift the hive off the stand and put it down to one side. On the old stand place an empty hive, affixing an entrance-guard. (See Drones.) Take the frames one by one out of the old hive, and shake them in front at the entrance of the empty hive on the old stand. Black bees fall off very readily; and as they crawl toward the hive the queen can be easily seen; but if she eludes scrutiny she will be barred by the queen excluder, where she may be readily discovered trying to make her way through. After all the frames are shaken, if she can not be found, take the old hive, now empty, and dump it, causing the bees to be thrown before the excluder. She will soon be seen trying to pass the guard. Under head of Introducing, subhead, How to Introduce to Black Bees, will be found a method that is very satisfactory.

So far, details have been given on how to find the queen; but the reader must not imagine that it is going to be as difficult as this every time. She is usually to be found on the center frames; and, especially with Italians, found on the first or second frame handled.

Why Hoffman Frames

When unspaced frames or frames without spacing shoulders are put back in the hives they must be spaced carefully 1⅜ inches from center to center as near as it is possible. It is not practicable by the rule of thumb or finger to get them all exactly this distance so that there will be some combs a little thicker than others, even when the greatest of care is used. If one is a little careless (as most people are) there will be considerable variation in the thickness of the combs, and the thicker ones will have to be shaved down with an uncapping-knife at the first extracting. If the combs are left thick and thin there will be danger of killing a good many bees in inserting and removing the frames, especially when the position of the frame is changed. All of this nuisance of irregularity in thickness of combs can be avoided by the use of self-spacing or Hoffman frames.

There is not much danger of killing bees provided one proceeds carefully, using a little smoke in blowing the bees away from the contact edges of the frames. When the hive is ready to close up, all that is necessary is to shove together the frames that are separated two and three inches apart, and crowd the whole together, finally putting on the cover. On the other hand, when unspaced frames are handled, each frame must be put back into position separately. This takes a large amount of time, whatever may be said of the time consumed in separating spaced frames. (See Frames, Self-spacing; also Frames.)

Mr. Hoffman, the inventor of the frames, stated that the judicious use of a smoker would save time, avoid bee-killing, and, taking it all in all, he could handle twice as many colonies on his spaced frames as he could on the ordinary old-style frames without spacing attachments. This has been the experience of others, including the author.

How to Manipulate Hoffman Frames

The manner of opening hives containing Hoffman or any other self-spacing frames, is just the same as that for hives containing loose or unspaced frames already described, but the manner of handling the combs is somewhat different.

If there is a division-board in the hive this is first removed in order to give room for the handling of the frames themselves. If there is none the outside frame is pried over to the side of the hive and lifted out very carefully. This will then make room for the removal of any two, three, four, or five frames, all in blocks. As an ordinary Hoffman or self-spacing frame will be somewhat glued together by propolis, it will be necessary to use the hive-tool to separate the frames.

In removing self-spacing or Hoffman frames from a brood-nest, it is not necessary to scatter them all around the outside of the hive, leaning them up against each other in such a way that it kills bees, but each group of frames, two, three, or four, as the case may be, can be left sticking together, stationed on the outside of the hive. There is no danger then of killing the bees between the frames, and the necessary information can be secured from the one or two surfaces of combs examined. When the or-

dinary unspaced frames are used it is necessary to handle each frame individually, because they can not be picked up very well in groups of three or four like the Hoffman or any other good self-spacing frame. (See Frames, Self-spacing.)

In ordinary practice it is not necessary to hunt up the queen. The examination of the surface of one or two combs will show whether eggs are being laid. If eggs and brood in various stages are found in regular order it may be assumed that the queen was in the hive within three days at least.

The location of the queen can be determined somewhat by the manner in which the eggs are laid. If the examination of one comb shows no eggs and an examination of another shows that there is young brood, the position of the queen can be traced by the age of the brood until eggs are found; the queen may at the time of the examination be at one side of the brood-nest rather than the other. After she goes clear across she is quite liable to move from one side clear to the other.

Sometimes the behavior of the bees is such as to indicate where the queen is. Her location can generally be determined immediately after releasing the queen when introducing, because the bees will have their heads pointing in her direction; and sometimes by a hum of rejoicing the queen can be traced, especially if she has been well received.

Dislodging Bees from Combs

For many manipulations like giving brood to another hive, or for the purpose of extracting, it becomes necessary to dislodge the bees from the frames. This can be done by brushing them off as shown under Extracting, or they can be pounded off with a blow of the fist on the back of the hand grasping the end-bar. Or one may grasp the end-bars solidly, and with a quick downward jerk remove all or nearly all of the bees. When more convenient one can swing the frame, pendulum fashion, with one arm, letting the corner drop violently against the ground while the other end is held in the hand, as shown on next page.

How to Ascertain the Condition of the Hive Without Handling Frames

Most beekeepers operate on the tier-up principle, leaving all the supers on the hives until the season is over. By that time it is important that robbers be given no opportunity to help themselves to sweets, when the honey is taken off; but before doing so the condition of the supers should be determined in advance.

Formerly it was the practice to place the new super of empty combs under those partly filled. Now it is the practice to put the empty on top. (See Supering further on.) By lifting off the top super the condition of the lower can be easily determined.

In order to determine the amount of honey in any super, it is not necessary to take off the cover and pull the hive apart. If it is tiered up four and five stories high, it involves a large amount of labor and considerable lifting to pull the supers off one by one, inviting the attention of robbers in the operation. If one is supplied with a good strong steel hive-tool and a smoker, he can get a fair idea of the filling of any super without even removing the cover from the hive. In the series of snapshots on page 531, the reader will be able to gather almost at a glance, the exact method to be used in determining what the bees are doing.

Take an example. Loosen all the supers with the super tongs, shown on page 524, by lifting up on the lever. Let the operator start with the hive shown in Fig. 5, page 531. It has three supers. The middle one is the one on which the bees began work first, and at the time of this

How to bump the bees off a comb.

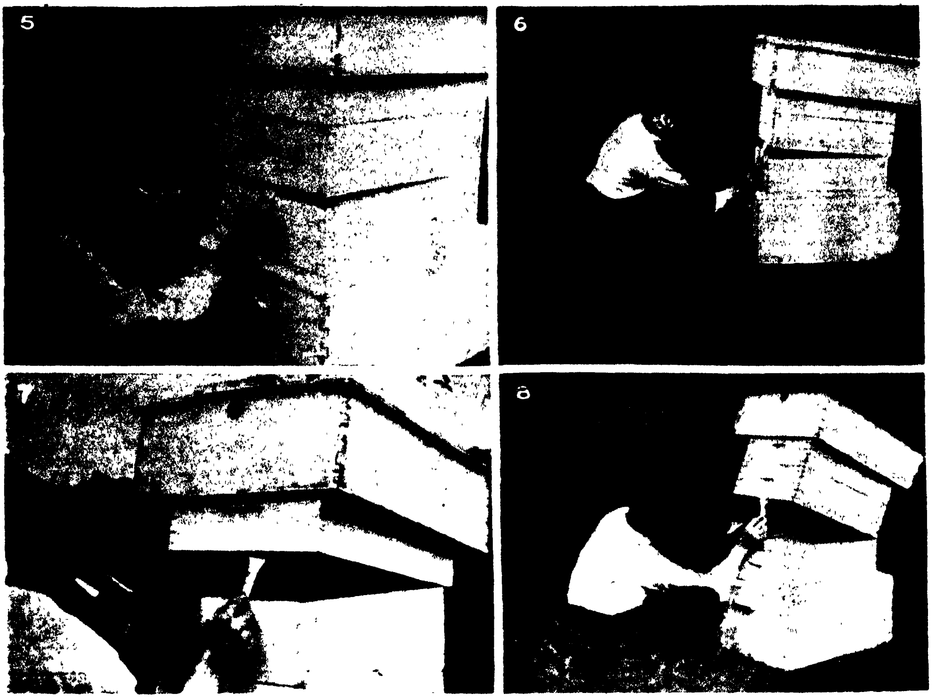
Dr. Miller's method of jarring bees off the combs.

examination it should be completely filled. The bottom super was placed under after the middle one was about half filled. The colony was again crowded for room, but since there was only a week or so more of honey flow, the third super was put on top, so that the first two will be certain to be completely filled before the bees begin work on the third.

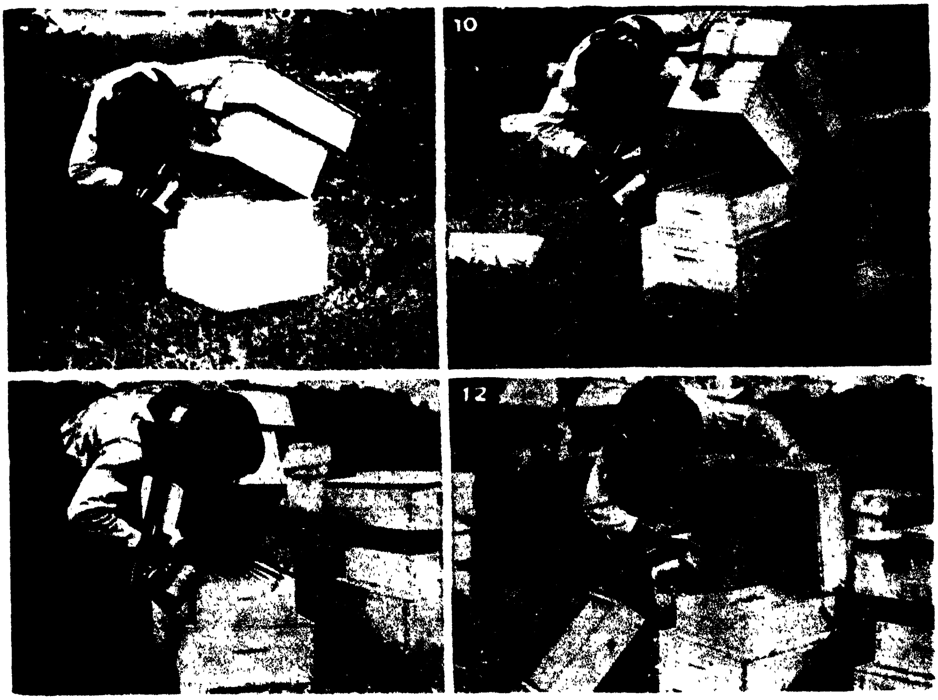
At this time it is desired to know what the bees have actually done; so, without removing the telescope cover on top nor the super cover directly beneath, the thin blade of the hive-tool, broad end, is entered between the two lower supers, at the back end of the hive; for one should always endeavor to keep out of the flight of the bees. This is gradually shoved in until the blade has been pushed in anywhere from ½ to a full inch. A gap is now formed, of approximately ⅛ inch, just wide enough so that a little smoke will drive back the bees. A slight pressure downward separates the two upper supers about an inch at the back end, when more smoke is blown in. The tool is pushed down a little further, making the gap a little wider. (See Fig. 6.) But the operator is not quite satisfied as to the condition of the supers, so he pushes the tool and supers upward, as shown in Fig. 7, until he has the hive-tool in position as shown in Fig. 8. Here it acts as a prop, when, with the intelligent use of the smoker, he can drive back the bees enough so that he can see the condition of the two supers, or enough to determine whether the bees need more room.

But suppose he is not quite satisfied yet. As shown in Fig. 9, he lifts the supers higher, disregarding the hive-tool falling on the ground. When doing this he slides the two supers about an inch backward so that the other end will fulcrum on a safe bearing. If the super is slipped forward, as shown in Fig. 7, it can be readily seen that it can not be tilted up very high without sliding off in back. (See Figs. 9, 10, 11.)

Usually an examination of this sort is quite sufficient. If the supers are not filled they are quietly let back into place, using sufficient smoke to drive the bees away so they will not be crushed as the hive parts come together again. The operation shown in Figs. 5, 6, 7, 8, 10, 11, is then repeated with other hives, taking from 30 to 60 seconds per hive. At no



Learning condition of hive without removing cover or pulling to pieces.



Determining the filling of the supers and whether ready to come off.

time has the operator lifted but a part of the dead weight. When the supers are held at an angle the load is on the fulcrum point of contact, while the hand sustains only a small part of the weight.

Fig. 12 shows the method employed when supers are apparently well filled and ready to come off. The top super is removed and leaned up against the leg of the operator. The middle super that has been filled can now be taken off; but before doing so a second examination is made as shown. It is set off, when the bottom super may also be removed if ready. If so, the top super is put back, the purpose being to confine the bees to as small a super capacity as possible as the season draws to a close, in order to make the bees finish their work.

Fig. 13 shows a slightly different pose from that indicated in Fig. 8. While the position of the operator is somewhat cramped, it is true, yet it is much easier than tearing down the hive super by super, and replacing.

Of late years, it is beginning to be the custom to put the empty super on top when the bees need more room, instead of placing the empty above the queen ex-

Fig. 13.—How a smoker and a hive-tool will enable one to learn the condition of the supers at one glance.

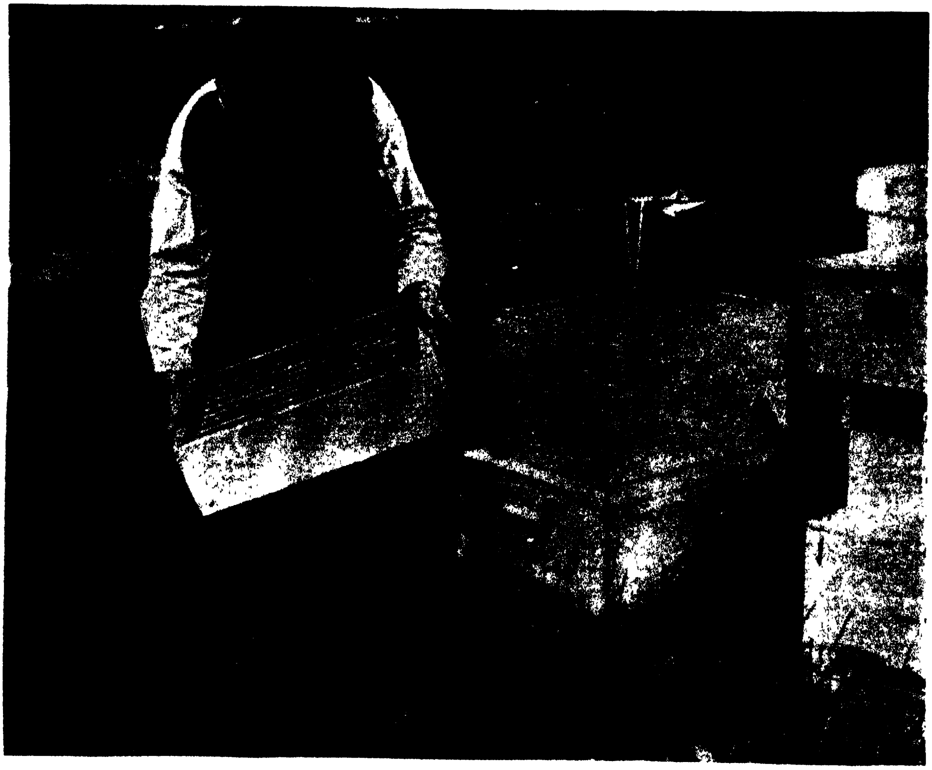


Fig. 14.—Shaking bees out of a super.

Marigold, great honey plant of Texas, but found all over the United States.

cluder and below the supers partly filled. When the later practice is followed, it is not necessary to follow the procedure just given of lifting heavy supers in order to get a view of what is going on in between. All that is necessary without lifting any heavy supers is to lift the cover and examine the top super only. If that is not filled it may be assumed, of course, that the bees have plenty of storage room, and no additional room will be needed.

The new practice of putting on supers is given under the head of Supering further on in its alphabetical order. This will show how to avoid heavy lifting of any super until the crop is ready to take off.

In Fig. 14 is a case where the season is closing abruptly. The bees have only partially begun work in the top super. To leave it on would mean that all the supers would have honey in, and none of them quite completed. Accordingly the bees are shaken out of the top super when it is moved. If there should be some good rains and warm weather, the season may take another start. In that case a super cover temporarily placed between the top super and the two below is removed, when work will be resumed in the third super. If it could be known that the season was drawing to a close, the top super should be removed in the first place. How to get bees out of supers, see Comb Honey, pages 197 and 198.

MANZANITA (*Arctostaphylos manzanita*).—See "Honey Plants of North America."

MAPLE (*Acer*).—The maples bloom so early in the season that their value for pollen and honey is greatly underestimated. In early spring the colonies are so weak that a surplus from this source is seldom obtained, and the maples are regarded as important only for brood-rearing. There are about 100 species in the genus *Acer*, which are confined chiefly to the northern hemisphere. Many of the trees are very common and the rock maple forms extensive forests. In the states east of the Rocky Mountains a small surplus of maple honey has been reported in Iowa and Alabama. See "Honey Plants of North America."

MARIGOLD (*Gaillardia pulchella*).—See "Honey Plants of North America."

MARKETING HONEY.—The average beekeeper, unless he is a natural or experienced salesman, would do better to sell to some one who is. Where the crop is small, one can sell to the local grocer or retail from the roadside. It is one thing to produce a crop of honey and quite another thing to sell it. During the period of the Great War, when sugar could be obtained only in very limited quantities, there was no difficulty about selling honey either in small lots or car lots at high prices. Shortly following the armistice there was a period when there was a buyers' strike, when practically all commodities, including honey, were a drug on the market. The result was that producers all over the country were trying to sell in a retail, wholesale, or jobbing way. It was then that many a producer found he was not a salesman.

The question of selling at retail or in a small way will be discussed further on. The problem of the beekeeper who has from 100 to 1,000 or more colonies and who sells in large lots requires some consideration. These larger producers are usually not salesmen, and it therefore becomes necessary for them to dispose of their entire product to some large wholesaler, jobber, broker, or commission house. A beekeeper with a hundred colonies during normal times has no difficulty in selling his entire product to the wholesale grocery and in some cases to the retail grocer. He may find it possible to sell to a dealer who handles dairy products, because honey, butter, and milk, including ice cream, are often sold from the same counter.

There are now large buyers of honey in nearly all the large cities of the United States. They will usually, during the selling season at least, take honey at its market price in lots of a thousand pounds to a whole car load. They will sometimes on a rising market buy ten cars. They will have their buyers located in various cities, and, of course, they will seek to get the honey at the lowest figure possible.

Occasionally large producers are organized into exchanges through which the products of its members are sold, but it should be said in all frankness that there are only one or two of these that are successful and giving satisfaction. The United States Bureau of Markets is sending out direct to beekeepers reports of sales for the various markets of the country. Information gleaned through this source and through the bee journals will usually give one a fairly accurate idea of prevailing conditions and whether he can afford to sell. A producer who thinks that it is unnecessary to take a bee journal is making a serious mistake. Without the information given on the market pages he may sell a cent or two below the market.

On a rising market one can sometimes afford to hold his crop, but he should also remember it is wise not to wait too long. Marketing in a carload way usually begins in September. The price may rise during the months of October and November. From the middle of November to about the first of December prices usually reach their maximum. Sometimes the market will hold strong after the holidays but usually the demand is slow and irregular from that time on until the new crop is ready.

During later years, however, it is encouraging to note that the honey market in car lots shows more and more an inclination to hold a general level throughout the season.

Producers should clearly understand that the amber or dark grades of honey usually bring in car lots from one to two cents less per pound than the light-colored or table honeys. It should generally be understood also that honeys of

the North are usually superior in color and flavor to those of the South. As a general rule, the farther one goes toward the equator the darker will be the honey. There are some marked exceptions to this, however, as one will see by consulting the article, Honey, Colors of, and Honey, Flavors of.

Selling for Cash

Where possible one should always sell for cash. But before doing so it is necessary to know the financial standing of the jobber or dealer making the offer. Many a beekeeper has sold his honey to a concern without a rating, only to find he has lost his honey and that the account is not collectable. Some of the representatives of these concerns are smooth, plausible talkers but are dishonest. They know enough about law to keep themselves safe from prosecution. No one should sell his honey to a stranger without inquiring first at the local bank of his standing. If he is not rated let him alone, unless he can pay cash or by a certified check. Your banker can by wire or letter soon determine whether the check is good. If one can not get satisfactory information from the bank, he should write the publishers of one or more of the bee journals. It will take only a few days to get a report, and it may save for the producer his entire crop of honey.

It is pitiful to read complaints from beekeepers who had tried to collect from parties without a rating, but who, in order to get the honey, had offered prices above the general market to catch their "sucker."

Much honey is now shipped in car lots, a draft being attached to the bill of lading. The producer may feel that it is perfectly safe to ship in this way, and usually it is, as the money must be paid to the bank before the honey is delivered. If the concern is not reliable or dishonest it may seek a consignment in this way with the deliberate intention of rejecting the car, thus placing the producer at a great disadvantage and making him feel he will have to accept the terms offered in order to dispose of the honey. If he does not accept such terms it may be necessary for him to make a trip clear across the continent, in the meantime paying demurrage to the railroad company while he is seeking a new customer.

Taking everything into consideration the producer should deal only with well-known responsible concerns that can furnish good references as well as satisfactory rating in either Dun's or Bradstreet's commercial agency. In the case of a new company, it will be well to learn what the bee journals think of them.

It is sometimes not practical to sell for cash. Perhaps no offer can be secured. In that event honey may sometimes be disposed of to good advantage to reliable commission houses.

Selling Honey to Commission Houses

In all large cities there are what are known as commission houses who will receive, store, and sell farm products on a commission basis of from 5 to 10 per cent. If the commission man is honest he will sell to the highest bidder and then remit to the farmer or beekeeper the proceeds from the sale, less freight and commission. If the producer at the time of making shipment specifies that his product shall not be sold for less than a certain figure, the commission house is legally bound not to sell for less. In case the price is too high, he is supposed to notify the shipper, and if the latter gives his permission to sell for less he may do so. If the shipper insists on his price, he is expected to give instructions to turn the shipment over to some other house.

Theoretically, the plan of selling on commission is ideal. Producers assume that the commission house knows better than he does what his product ought to bring. If the house is honest it will secure the very best possible price that the market will pay. The commission house runs no risk. It does not pay for the goods until it has sold them and has the cash in hand to send to the producer. The latter, if the deal is square, is satisfied.

But too often the commission house took advantage of his client. He sold for a higher figure, but took his commission out of a lower price. The shipper in most cases would have no means of knowing that he should have received more.

Sometimes the commission man would claim that the product had spoiled, or that it was inferior in the first place, when, as a matter of fact, it was neither. The producer is miles away and he can not investigate, so he takes what he can get, though he is very much dissatisfied.

It was for these and other reasons that the selling of honey on commission gradu-

ally grew into disfavor until practically all honey sent to a distant market is sold for cash.

In this day and age when Government Market Reports are available to every one for the asking, whether he is a farmer or a beekeeper, the producer has a means for knowing what his product should bring. He sends a sample to the buyer. If the latter makes a satisfactory offer the deal is closed; but remember the instructions given at the outset, not to sell to irresponsible buyers.

Selling Honey in a Retail Way

The beekeeper with four or five colonies of bees will have no difficulty in selling his honey to his neighbors. It soon becomes known that he has a few hives of bees, and the people in the vicinity, feeling that they can buy "real honey," will go to the neighbor and pay good prices furnishing their own utensils. If the honey is of first quality there is no trouble about selling the entire crop from the doorway.

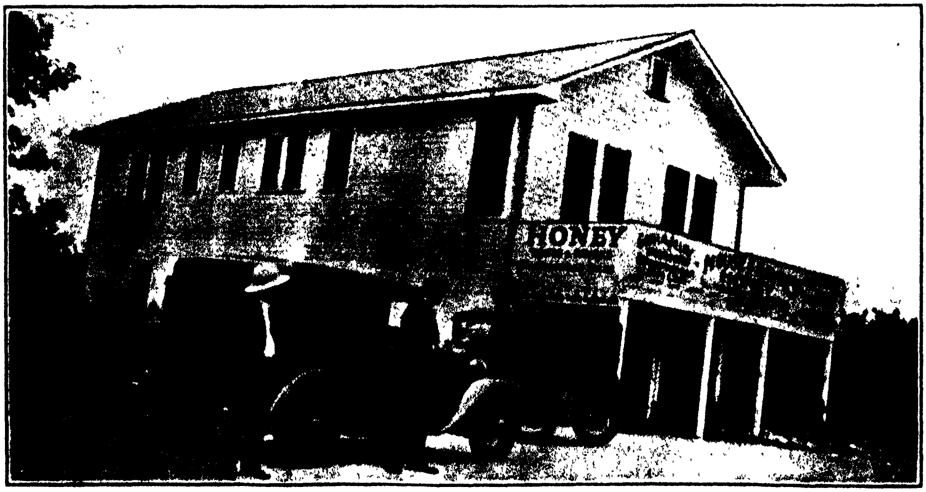
When one has from fifty to a hundred colonies his problem is not so easy. If he is not a salesman he should dispose of his honey in a wholesale way to his local grocer. If he is located in the country on a main highway where automobiles are passing, he may be able to sell his entire crop from the roadside the same as ordinary farm products are sold. He should be careful to consult the market to learn what the retail prices are and sell it at retail. It is always a mistake to cut prices under the grocer, because if the beekeeper ever antagonizes that individual he may shut off an important outlet for his honey some seasons when he can not sell his entire product from his home. In any event, it is always wise to co-operate with the local dealer as far as possible.

If one is a natural salesman he may be able to dispose of his entire crop by peddling; for particulars on how to do this, see Honey Peddling.

It should be emphasized that the honey sold should be of uniform quality and good flavor. The poor or dark honeys, inferior in flavor, should be disposed of to some jobber for manufacturing purposes. In large quantities such honey is used in the baking trade. There are some honeys while dark in color are excellent in flavor. Such honey for example is tulip poplar.

Roadside Selling

Whether selling from the roadside or from the shelves of the grocer, the beekeeper should have his goods put up in neat, attractive form. Cheap labels or poor glassware have a tendency to give the honey a cheap look. The more attractive the package, the more readily it will sell. It is usually customary to put up the honey in tumblers, one-pound and two-pound glass jars, $2\frac{1}{2}$, 5, and 10 pound self-sealing tin cans or pails. It is advisable to use a container that the house-



House & Haynes, Dunedin, Fla., main selling roadside stand. The rear room is used for extracting and the upper story for the residence of Mr. House and family.

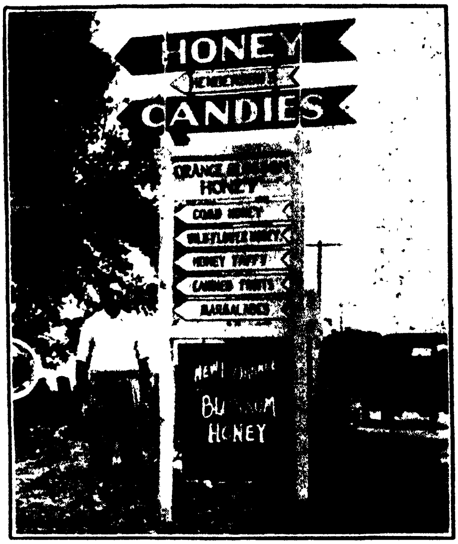
wife can use over again. Tumblers, Mason jars, and tin pails are always useful around the home. Glass packages should be of clear glass and not a pale green.

Labels should not only be attractive but show in pounds and ounces the exact amount of honey in the packages. They should be printed by some concern which makes a specialty of printing labels, and not by some local printer who puts neither art nor style into the label.

In roadside selling the sign should be neatly lettered. Signs poorly lettered,

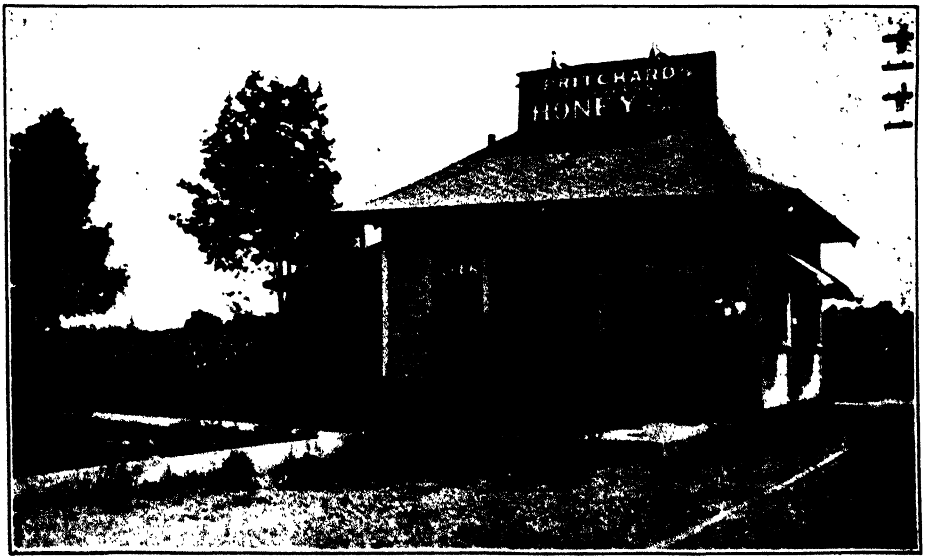
Mr. House's honey selling and delivery truck. The rear door is a great convenience for loading and unloading.

especially with the words misspelled, often do more harm than good in disposing of the honey. It is advisable to have about a dozen signs a foot or eighteen inches long containing the simple word "Honey." One of these signs should be placed about every hundred feet down the road each way toward the place



A very unique honey candy sign owned by W. H. Henderson, Dunedin. Fla.

where the honey is to be sold. There should then be one large sign calling particular attention to the goods and prices. Honey should be on display in a neat



The Pritchard honey stand as it appears when approaching from the north.

little booth, showing both tin and glass packages. If a customer wishes to sample, give him a liberal taste.

The Pritchard Honey Stand

The Pritchard honey stand is on a convenient parking space just off a main road. On either side are flower gardens. Inside there are chairs and luncheon tables on which honey ice cream, honey cakes, and honey crackers are served with soft drinks. As one sits down to one of the tables, the light shimmers through the bottles of honey that are set in the large plate glass windows.

There is no one constantly in the building except on busy days. A sign greets the prospective customer inviting him to "push the button." Immediately a pretty girl comes out of the house. This girl may be the mother or daughter, both of whom know how to tell the story about the queen and the bees. A winning smile causes a bottle or tin of honey to come off the shelves; or it may have the effect that the whole automobile load sits down to honey ice cream, honey candy, and honey cakes. In either case the motor crowd goes away sweetened up for all day. A week or two hence, the memory calls for more honey, perhaps 1000 miles away. The Pritchards are in this way advertising honey up and down a 1000-mile road.

Advertising Signs Calling Attention to Roadside Stands Selling Honey

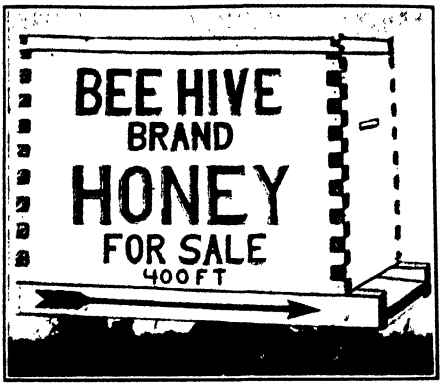
It is very important to have these signs distributed for a mile or so from the honey stand in each direction. An ideal arrangement is to have one sign a mile back, another say a half-mile, and another 1000 feet from the honey stand itself. The first sign is to get the motorist to thinking, the next is to whet his appetite for honey and the last is to cause the determination to stop.

Signs should be scattered along the roadside for some distance from the stand.

The Pritchard outfit represents the all-the-year-round honey selling stand. On a main highway where there are thousands of machines passing, especially on big days, one can put an elaborate building that can be heated by a small gas or coal stove; but there are other routes where a much less expensive outdoor display of honey can be established. Mr. Edwin W. Selfe of Monroeville, Ohio, has such a stand that is very effective. To arrest attention he has novel signs 1000 feet in each direction. Instead of showing an old-fashioned straw skep, the usual emblem of bees and honey, he shows a picture of a modern dovetailed hive twelve or more

Hagin's gas station where honey is sold. The beeyard furnishing the honey is shown in the distant background. This station is ideally located at a fork in the roads.

feet each way. At a distance it is very striking. There are several of these signs, big and little. The one near the honey stand itself has a hive in the rear so placed that the bees go in and out at the



This mammoth beehive honey sign is so big that motorists can not miss seeing it.

entrance of the hive painted on the bill-board.

Mr. Selfe thoroughly appreciates the value of advance signs up and down the road each way. Unless there are these "advance agents," the average motorist will see the sign too late and rush by. With the congestion of traffic he can not now back up without great danger to himself and the oncoming automobiles. To drive up the road a half mile to find a place to turn around—well, he will not do it. There is no use putting up a roadside honey stand unless there are also placed "advance agents" in the form of appropriate signs calling attention to the honey stand so many feet ahead. The motorist is then notified in time and will stop, if he is honey-minded.

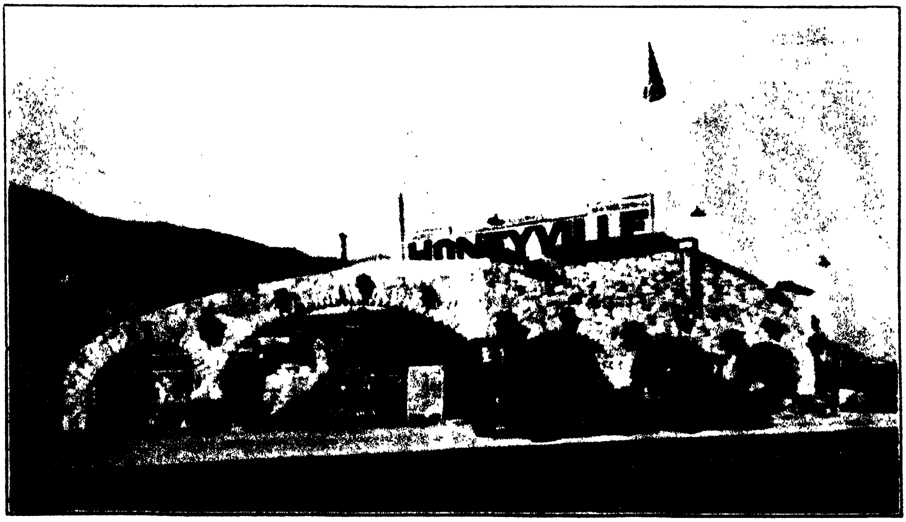
The Folly of Cutting Prices

It is a mistake to place a honey stand near one that is established and doing a good business. It is poor business judgment and unfair to a fellow beekeeper. The new man will cut prices to draw trade. Stand No. 1 goes one better, and the merry war of price-cutting goes on to the harm and destruction of both.

Live Bees at Roadside Stands

Beekeepers can greatly stimulate a demand for honey by placing a single-comb observation hive in show windows. Live bees on the comb are always an object of interest. The public never tires of them. The big and important thing they do is to stop pedestrians and motorists. It is then opportune to get in a sales talk. Honey, produced by bees, can be sold by bees; and they will do it if you give them a chance.

Bees that are confined for a whole week in a glass hive without a chance to fly



The most elaborate roadside honey stand in the world located 23 miles from Los Angeles, California, and 3023 miles from New York, N. Y. While honey is sold at retail at roadside stands all over the United States, it is especially featured in California, where both California oranges and California honey are sold on all main highways.

will become listless and stain the glass. They should be changed every two or three days, certainly every three days to keep them fresh. Better by far fix up a tube or chute from the entrance to a point at the top of the window sash so that the constant flight of the bees, well above the heads of the passers-by, will keep them fresh. (See pages 448 and 449.)

When one of these glass hives is filled with bees and the comb shows brood in all stages, the queen, and the bees, it makes an exhibit that commands attention from the public. Obtain permission from the groceryman to put one of these glass hives containing live bees in his show window, place around this glass hive both comb and extracted honey in attractive packages. A display card should explain something about the bees and how they work, and the queen. On important days and Saturday afternoons the beekeeper himself should get into the show window and tell how honey is produced, also about the queen, bees, and drones.

At such a time it is advisable to have an open can of honey. If the demonstrator is provided with small wooden paddles, he can dip one of these into the honey and ask the prospective purchaser to taste it.

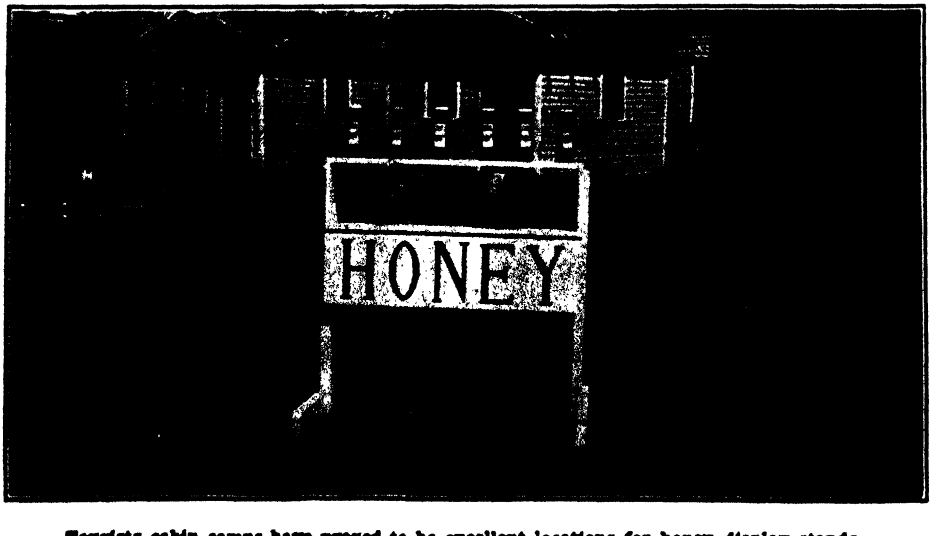
If the local beekeeper is not a good talker, let him employ some one who is, and he will be surprised how his honey will sell.

Grocerymen are usually very willing to grant window space and otherwise get back of the whole scheme of selling. They sometimes have a member of their selling force who can do the "demonstrating" better than the beekeeper himself, especially so if that beekeeper is not a natural talker or salesman. (See Observatory Hives.)

This kind of demonstration work with live bees on display can be undertaken most profitably at county fairs, street fairs, or at food shows. Sometimes space can be secured in one of the buildings. At other times it may be advisable to have a special tent at some good location on the grounds, where honey can not only be sold but where a good demonstrator can help push the sales.

Where possible, let the beekeeper open a hive inside a wire cage. This cage is usually about six feet high, four or five feet wide, and six feet long. Inside of the cage an operator without bee-veil or gloves, can show just how he handles bees. If it is advertised that bees are manipulated in this cage at certain hours during each day of the fair, large crowds will come to see the man, bare-handed, barefaced, handle the bees. With a good salesman or saleswoman at the tent, large quantities of honey can be sold. (See Honey Exhibits.)

A large and important advantage secured from this demonstration before the public is its permanent advertising value. If these demonstrations are then followed



Tourists cabin camps have proved to be excellent locations for honey display stands.

up with appropriate window displays at the local groceries, there will be no trouble about the selling of the honey.

How to Make a Sign "Honey" with Raised Letters

Benjamin Nielsen of Aurora, Nebraska, has devised a simple and unique way of making a large raised letter sign that can be seen at a distance. He thus describes it:

Signs play a very important part in the drawing power and attractiveness of a roadside stand. Honey signs seem to have lagged far behind other business signs. An inexpensive but attractive stand can be built for a few dollars.

The sign illustrated is set as close to the road as possible and can be seen plainly at a distance of nearly one-fourth of a mile. Mounted on four by-fours, seven feet high, the sign is eight feet long and two-and-one-half feet wide. The letters are seventeen inches high and eleven inches wide. They are cut from three-quarter inch material and are two-and-one-fourth inches wide.

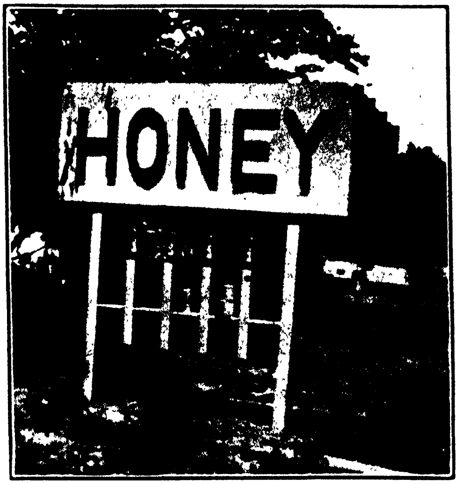


Fig. 1.—Modernistic sign, gaily colored, which is sure to be seen by passing motorists.

Fig. 2 shows how these letters are cut easily and to the best advantage. The front edges are rounded. However, care should be taken not to round any edges where the letters join.. Careful study of the picture will help to point out these places. The letters are mounted on an ivory colored background of galvanized iron. Pressed wood may be used to very good advantage. Nails may be used to fasten the letters in position but screws were used for these letters. Both faces of the sign are mounted on a wooden frame, Fig. 1.

The underside of the letters are given a coat of paint for protection. All other parts of the sign are given two coats of ordinary outside paint and a finishing coat of enamel. The enamel coat pays well for it stands up much longer, is shiny and makes a much nicer looking sign.

Before any paint is applied to the galvanized iron it should be washed with vinegar to assure a clean surface to which the paint will adhere without peeling off.

In painting the letters much time and trouble will be saved by grasping the piece firmly in one hand, thumb on top, painting the edges and flat surfaces to the thumb, then placing on drying rack to finish.

To be fully appreciated the sign should be seen as the color combination can not be brought out in a picture. In this the background is ivory or light cream, the modernistic strips at the side are yellow, orange and Chinese red. The letters are also in Chinese red. Display parts and uprights are painted, alternating cream and Chinese red. The frame is red.

MATING OF QUEEN AND DRONE. —See Drones; also Queens.

MESQUITE (*Prosopis glandulosa.*)—In the United States there are two species, *P. glandulosa* and *P. velutina.* Texas mesquite (*P. glandulosa*) is also called algaroba and honey-pod. In the lower Rio Grande Plain it is a large tree attaining a height of 40 feet and a diameter of 2 feet; but on the dryer soil south and southwest of San Antonio there is a vast mesquite forest consisting of trees 10 to 15 feet tall. On arid land the mesquite becomes a straggling shrub with crooked branches. It is found from Kansas to Texas and southward into Mexico, and westward to New Mexico and southern Nevada.

The mesquite has usually two separate and distinct blooming periods during the year, although in some seasons there is no interval. The first comes during April and the second during the last of June or in July. These periods are sometimes a week or more earlier or later according to the

Fig. 2.—Parts of letters ready to fit together.

season, the occurrence of cold weather and the rainfall of the preceding fall and winter. If rain has been abundant during the winter, no matter how dry the following spring and summer, there will be a profusion of bloom and a heavy flow of nectar. The long taproot penetrates the soil to a great depth and is thus able to obtain water which is beyond the reach of many other shrubs and trees.

Mesquite is one of the main honey plants of Texas and the source of a very large surplus. From 25 to 100 pounds of honey per colony are stored from the bloom according to the locality and weather conditions. The honey is light amber in color and of good quality. It is a better table honey than any other of the Texas honeys, since one never tires of it, as is apt to be the case with a honey having a more pronounced flavor. The honey, although ranked very high in Texas, would in the North probably be classed with the amber honeys. Nectar secretion is more reliable on light sandy soils than on heavy land.

In New Mexico in the valley of the Rio Grande River beekeepers formerly depended on mesquite and other desert plants, but now pay attention only to alfalfa and sweet clover.

Arizona mesquite (*Prosopes veluntia*). This tree is the largest of the mesquites, often attaining a height of 45 feet or more. It grows in the hot dry deserts of southern Arizona, southern California, and Sonora.

Mesquite in the Hawaiian Islands

In the Hawaiian Islands mesquite is not only the chief but almost the only source of floral honey. Here it is called algaroba, or in the native tongue, *keawe*. See "Honey Plants of North America."

METAMORPHOSIS OF BEES. — See Brood and Brood-rearing.

MIGRATORY BEEKEEPING.—Experience has shown that the secretion of nectar in a given locality varies sometimes, even within a distance of only a few miles. Sometimes the home-yard bees will be gathering no honey when an out-yard eight or ten miles away will be securing a good crop. This is due to the fact that the character of and moisture in the soil make possible the growth of some plants that will not take root in other locations only a few miles away. For example, a bee-yard may be situated in a valley close to a stream, along which there will be a heavy growth of honey-yielding plants. Within a few miles from there, perhaps on higher ground, and soil less productive, there will be nothing.

Sometimes one finds conditions like this: in one locality a large amount of buckwheat will be grown; ten miles away from there, there will be none whatever. The same is true of red clover, alsike, and a number of other artificial-pasturage crops.

Again, in one year when there is an excess of rainfall the location in the valley will be too wet for the proper growth of plants yielding nectar, while on the higher ground, a few miles away, conditions will be just right for a fine flow of honey.

The knowledge of these varying conditions in localities only a few miles apart has led some beekeepers to practice what is known as migratory beekeeping. For example, in one yard it is evident that bees are not getting any honey, and there is no flora of any sort that gives any promise of any. Not far away is another yard that is doing well. It is good business to move the yard that is yielding no returns to the location in which the honey can be secured.

In many eastern states sweet clover and alfalfa are being introduced. Where there is one or both bees can often be moved from white clover and alsike into sweet clover and alfalfa.

In California, for example, it is quite customary for the beekeeper to move from the orange district into one with an abundance of sage, then from the sage into the bean fields, or into localities where alfalfa is being grown. Similarly, bees in the East are moved from the clover into the buckwheat fields. For particulars on moving bees, see Moving Bees. Migratory beekeeping is being practiced on a large scale in the extreme western part of the United States. Bees are being moved in car lots from Texas, Idaho, Montana, and Nevada into California and back again. In many cases the large producers find that they can move the bees from Idaho, Montana, or Wyoming in one or two car lots in the fall to the citrus groves of California, build them up on eucalyptus during the winter, catch a crop of orange honey in the spring, then mountain sage, after which the bees are loaded on the cars and moved to the state whence they came

Common milkweed.

where they catch a crop of alfalfa. In one case in particular one large producer says he cleaned up in this way $50,000 in one season; but this was during wartime prices when honey sold at 22 cents a pound in car lots. Some good beekeepers, even with normal prices, are making migratory beekeeping pay handsomely.

Bees are also moved in package form without combs in lots of a thousand pounds at a time by express. (See Package Bees.) One large producer in Nevada had 1,200 two-pound packages of bees sent him by express from California after the orange and sage bloom.

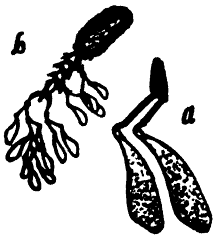
MILKWEED (*Asclepias syriaca.*)—Milkweed has been listed as a honey plant in many states, as Massachusetts, North Carolina, Tennessee, Texas, Nebraska, California, and Michigan; but it is comparatively rare in the prairie region. In Michigan, milkweed is very abundant in the northern part of the Lower Peninsula in Cheboygan, Emmet, Charlevoix, Antrim, and Grand Traverse Counties, where an average of 50 pounds surplus per colony is sometimes obtained. When the weather is favorable the nectar is secreted very rapidly, and a large colony may gather 13 to 17 pounds in a single day.

The common milkweed (*A. syriaca*) blooms from about July 15 to August 15. The honey is excellent and compares well with that obtained from raspberry. It is white, or tinged with yellow, and has a pleasant fruity flavor somewhat suggestive of quince, and with a slight tang. It is so thick and heavy that it may be nec-

essary to warm the combs before extracting. The cappings of the comb honey are nearly always pearly white. It sells readily by reason of its fine flavor, and is in every way suitable for table use.

The way in which the pollen masses are clamped to the feet or legs of insects is of much interest to beekeepers, and every season there are many inquiries in regard to this queer phenomenon. The bee can obtain its liberty only by breaking the connecting bands. If this happens, the pollen masses are left in a chamber near the stigma, and the bees bear away the membraneous disc with its empty stalks. Disc after disc may thus become attached to an insect until it is crippled or helpless.

In some cases many bees are lost. It was at first supposed that they were being destroyed by a fungus. Many different explanations have been given of these curious structures by persons not familiar with the flowers of the milkweed. Some think them a parasite, others a protuberance growing on the bee's foot, and others a winged insect enemy of the bee. An engraving of this curiosity, magnified at *a*, and also a mass of them attached to



Pollen of the milkweed attached to bee's foot.

the foot of a bee is here shown. If the insect is not strong enough to pull out the pollinia, or later to break the connecting bands, then it perishes slowly of starvation, probably with little pain. These dry membraneous discs are often described, even in botanical works, as glands, or as being glutinous or sticky, but this is not the case. See "Honey Plants of North America," by Lovell.

MOULDY COMBS.—See Combs.

MISTAKES IN BEEKEEPING.—We perhaps profit more by our mistakes than from some of our successes. But it is not necessary that everyone repeat the same mistake made by others, and so it has been thought best to recite here some of the common ones made by beekeepers.

The Mistake of Inexcusable Ignorance

Undoubtedly one of the most common and expensive mistakes is trying to get along without some good bee book or journal. There are not a few prominent beekeepers who feel they "know it all," and that the reading of a bee book or of a bee journal would be only a waste of time. Beekeeping, like every other industry or pursuit, is always progressive. New tricks of the trade are being discovered as well as new methods of marketing. It is important to have the groundwork of a reliable text book, then after that one should keep up with the times by constantly keeping in touch with the leading beekeepers and markets of the world.

The author has come in contact with many beekeepers, who own from three to four hundred colonies, but who take no bee journals, and if they have a text book they have not consulted it for years. A survey of their premises and their methods of work shows that they are much handicapped because they are pursuing old methods that have long since been discarded. Often they are selling at low prices because they are not in touch with the general market. These people are not only hurting themselves, but are doing a serious injury to their more progressive neighbors. These know-it-all people run along year after year wondering why they have poor seasons and why luck seems to be against them. They are just like the farmer with a run-down farm, poor equipment and poor buildings, who does not read any farm paper or thinks he does not need to read one. His machinery is out in the weather, he complains of hard times, is in debt, and is always jealous of his more successful neighbors who find it highly profitable to keep in touch with the best text books and papers that relate to the industry. So much for the mistake of inexcusable ignorance.

The Monumental Mistake of the 80s and 90s

Let us now point out some of the more common mistakes, even on the part of the beekeepers who read text books and bee journals. Perhaps the most monumental mistake, or error, of all beekeeping history was the fad of contraction. (See Contraction.) In the late eighties and during the nineties there was a fad for squeezing down the size of the broodnest so as to force all the honey that did

come in, into the supers. There were two methods of doing this. (1) reducing the ten-frame hive to five frames, either by taking out four or five frames from the standard brood-nest and putting in dummies; or (2) using what was then called the Heddon divisible-brood-chamber hive, and removing one brood section. (See Hives.)

The idea looked very alluring because it was argued that what honey did come in would be forced into the supers and that such honey could be sold for twenty or thirty cents a pound, and that the brood-nest could then be supplied with a five or six cent sugar syrup. On paper, at least, the scheme of trading a 5-cent syrup for a 25-cent honey was a sure money-maker, but in actual practice it meant an almost entire failure of the crop, primarily because the brood-nest was so small that the force of worker bees was entirely inadequate.

This school of contractionists, led by Mr. James Heddon, of Dowagiac, Michigan, with his divisible-brood-chamber hive, began to experience a series of poor seasons. Mr. Heddon himself, in his bee journal, raised the question why it was that the flowers did not yield honey. He, and all his brother contractionists, came to the conclusion that intensive agriculture had so occupied the former pasture lands that there was no clover or other honey flora available to their bees.

Fortunately there was another school of beekeepers, led by A. I. Root, Charles Dadant and others, who argued for strong colonies, brood reared in two stories of a Langstroth hive, or in a big hive. This school of beekeepers who believed in powerful colonies proved that their theory was correct by showing enormous crops of honey. But it took over ten years to prove the utter fallacy of excessive contraction.

For further particulars on this subject, see Heddon Hive under Hives. Likewise the general subject of Hives, subheads, Large and Small Hives and again the Demaree Plan of Swarm-control, by which brood is reared in two stories. A further discussion will be found under Food-chamber. Last of all read the general subject of Contraction.

Dickel and Other Theories

The Dickel Theory (see Dzierzon Theory) was another blunder, but unlike the contraction fad of the early eighties that wasted many thousands of dollars for its votaries, it did little damage beyond a waste of good printer's ink and paper.

In the same way the pollen theory and the sting trowel theory were both untenable, and yet bee journal space was worse than wasted. (See Honey, Acidity of.)

The Mistake of Small Colonies

Some make the mistake of using only a single Langstroth brood-chamber for breeding purposes. For an early honey flow such a colony will be too small.

After having read carefully the subject of Large and Small Colonies, under Hives, Brood and Brood-rearing, Breeding in Two Stories rather than in One Story, under Demaree Plan of Swarm Control, and Food-chamber, one will see the importance of having strong colonies. These can not be secured unless the brood nest is large enough, and unless also there is a large amount of natural stores in the form of a food-chamber, or combs of honey in the hive in early spring. A single brood-chamber in a Langstroth hive is not large enough to accommodate a good queen. Very shortly she requires more room, and then it is good practice to put on an extra story. (See Brood and Brood-rearing, Food-chamber, Demaree Plan of Swarm Control.)

One great reason why in some parts of Europe the crops of honey are so small is because the colonies are in very small hives. An old experienced beekeeper in this country does not need to be told that the big crops of honey come from a large colony of bees, 60 per cent of which are of flying age. There should be a total of from 75,000 to 100,000 bees, and in order to have this number it is necessary to practice the method described under Brood and Brood-rearing, Food-chamber, Demaree Plan of Swarm Control.

Sugar Stores Versus Natural Stores of Honey

In the former days, as has already been pointed out, it was considered good practice to take practically all the honey away from the bees, and sell it at 20, 25 or 30 cents a pound, and feed sugar syrup at 5 or 6 cents a pound. It was believed that sugar syrup, pound for pound, would go farther, was better for wintering bees, than natural stores of honey costing relatively much more. This is one of the mistakes of the early days. By reading up on the general subject of Feeding,

and Food-chamber, it will be seen that natural stores, when of good quality and sealed in the comb, will bring much larger returns in honey the next year than sugar syrup. While it is admitted that the syrup alone is perhaps a little better for the extremely cold part of the winter when there is no brood-rearing, yet for all-around winter stores there is nothing better than a good quality of sealed honey in sufficient quantity to last the bees from fall until the next honey flow. (See Feeding for Winter, under Feeding.)

Feeding in the Spring or in the Fall

Formerly it was believed that spring feeding to stimulate brood-rearing was good practice. It is now accepted that the syrup (or, better, sealed honey) should be given in the fall in sufficient quantity to last until the next harvest. Spring feeding — that is, giving syrup in small amounts for the purpose of increasing the amount of brood—stirs up a colony at a time when it should be kept as quiet as possible. As soon as the syrup is given the bees rush out into the weather, which may be cool or cold at the time. They rush out of the hive to find this sudden supply of stores. Some of the bees never get back. As a rule, the bees know best when to increase the amount of brood, and they will not go faster than the weather conditions or the size of the cluster will permit. But when artificially stimulated by feeding in the spring the brood circle is increased beyond the capacity of the bees to keep it warm. The result is that, after a cold period of a few days, much of the brood is killed. It is far better to give a food-chamber in the fall, and the bees will rear the brood the next spring as fast as they can well take care of it. (See Food Chamber.)

Mistake of Spreading Brood in the Spring

In olden days, as spring became well advanced, it was believed that it was good practice to put on empty comb in the center of the brood nest and if the colony was strong to insert between the combs of brood two or three such empty combs to stimulate the queen in egg laying. This spreading of the brood was a mistake in nine cases out of ten. It often resulted in chilled brood because the cluster could not cover all the brood.

When more room is needed, give an upper story or better, there should be a food chamber on top. When the bees or queen need more room, they will occupy the food chamber or that part of it where the stores have been eaten out. (See Food Chamber and Brood and Brood Rearing.)

Hives of Different Sizes in the Same Yard

Perhaps there is nothing more aggravating than to have hives of different dimensions in the same apiary. All the hives of a kind should be put in a yard by themselves. Otherwise, it will be almost impossible to exchange combs of brood, supers, covers, or bottoms, because the different parts of the hives will not fit together. Better by far start with only standard ten-frame Langstroth hives.

Locating the Hives Too Near the Common Highway or Line Fence

It is always a mistake to put bees too near a common highway, either a road or a common walk, or too near a line fence separating the owner of the bees from his neighbor. Some very expensive lawsuits have occurred because bees have gone across the line. (See Bees as a Nuisance.)

Poor Combs

It is a serious mistake to try to use poor, uneven, crooked, or drone combs, especially if not wired, in the apiary. As soon as they are once empty of brood or honey, they should be taken out of the hives and melted up into wax. (See Combs and Transferring.)

Poor Stock

It always pays to get a vigorous strong stock of Italian bees. While there are other strains that are good, they do not average up like a good strain of Italians that have given such universal satisfaction in the United States for over 75 years. One good queen is worth a dozen poor ones. It is always wiser to breed from the best stock and from the best drones. Poor bees are like scrub cattle —not worth their keep. (See Races of Bees.)

Scattering Foulbrood Through Carelessness

If one does not follow directions very carefully, under the head of Foulbrood, especially in the treatment of American foulbrood, he will be liable to scatter the disease, not only among his own bees, but among those of his neighbors. It is here that so many beekeepers make a costly mistake by not reading up before applying treatment. (See Foulbrood.)

Entrance Too Small or Clogged With Weeds

A large number of beekeepers do not appreciate the importance of having the entrances wide open during hot summer weather, or cleared of weeds or other roughage. A space in front of every hive should be cleared so that loaded bees, when they come in with honey, can go directly into the hive without having their wings torn. It is a mistake to have the entrances too large during winter. (See Entrances.)

Patents on Hives, Feeders, and the Like

Every now and then a beginner thinks that he can improve on the Standard hive or equipment. The patent office is full of worthless patents relating to bees. Most of them relate to feeders. Those who have been in the business all their lives know better than to attempt a new hive or appliance. They know that it would be folly to do so. It is one of the pastimes of beginners to invent a new feeder, or a new method of wiring frames. A few of them have merit, but most of them are worse than nothing. The ordinary second-hand five or ten pound tin pail with holes punched in the top, is as good or better than any patent feeder on the market. (See Feeders.) Some of the new-fangled feeders, costing anywhere from $1.50 to $2.00, some of the new methods of making controllable entrances, some of the new methods of wiring frames, are worse than useless because they are so expensive to apply. The price at which honey is sold will not warrant such expense.

MOTH MILLER.—In the old box-hive days and the early days of the movable frame the bee moth or wax worm was regarded as the most serious enemy with which the bees had to deal. Many of the beekeepers of those times were driven out of the business because their bees were cleaned out by the pest. So serious was it regarded that numerous moth-traps and moth-proof hives were invented and patented. These were worse than useless as they had all kinds of "retreats," cracks and crevices for the very purpose of trapping moths. Instead of catching them they made the finest kind of breeding places for the pest.

In this day and age the modern beekeeper regards the bee moth as more of a joke than a pest. In fact, it is almost a disgrace for one to allow it to get a start among his colonies or among the combs. It has been practically eliminated from all modern apiculture, and it is only occasionally that it gets in its work among good combs; and when it does, the owner is or should be ashamed of his own carelessness.

The bee moth does not exist as a real bee-enemy anywhere in the United States except in some of the southern states where black bees are kept in box hives exactly as they were in the days of our forefathers (see Enemies of Bees). Many there are just as ignorant of modern bee culture; and so today the bee moths, or, rather, the larvae of the wax moth, eliminate all except the very strong colonies. (See Box Hives.)

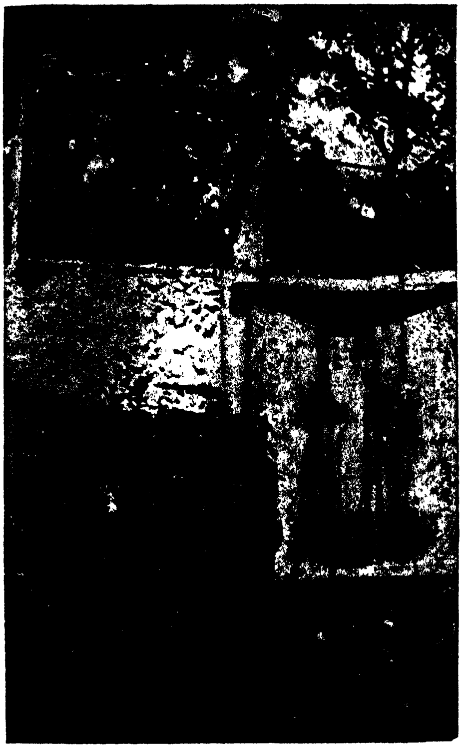
There are two species of wax moth—the larger one, *Galleri mellonella*, and the lesser wax moth, *Achroia grisella*. The former is much the more general, and, because of that, more destructive. Both species thrive among the ignorant and superstitious beekeepers, and particularly in box hives of black bees. In some of the southern states the bee moth is a serious enemy in that it destroys all second, third, and fourth swarms, leaving only the first swarm. Even the parent colony goes down with the rest. If it were not for the bee moth these old-time beekeepers would probably be keeping three times as many bees, and, of course, getting a proportionately larger amount of honey. Unfortunately, some of this class will not be the ones who read a work of this kind; and it is to be hoped that the extension workers sent out by the United States government will soon be able to teach them modern methods—methods that will eliminate the bee moth and render possible a very fair living. (See Box Hives.)

The statement was made at the outset that the bee moth is regarded as a joke by the modern beekeeper, and so it is. Since the introduction of the Italian bee and the movable frame there is no excuse for having the pest among colonies or combs. In the first place, the Italian bees themselves will eliminate it, whether it be in a nucleus or a strong colony. Even an admixture of Italian blood will keep it under control. A weak colony of black bees is easily destroyed by the bee moth.

How to Determine the Presence of the Wax Worms

The eggs hatch, and soon the larvae

begin their chank, chank, chank. If one will listen he will be able to hear



How the worms ruin combs.

these loathsome worms eating their way through the combs. Their presence can be easily determined also by a sort of webwork spotted with their excreta just beneath the surface of the comb, where, evidently they try to keep out of sight, and away from the bees. As they become more numerous they fill the space between the combs with web. In the earlier stages a few young Italians will keep out the worms and carry them out of the entrance, but black bees, unless the colony is a strong one, will let them go on until all the spaces between the combs are filled with web and these ugly wriggling worms. Brood-rearing will be brought to a standstill, and the elimination of the colony will take place about the time the old bees begin to die off. A strong colony of black bees will prevent the wax worm from making any progress in the hive, but a weak one of blacks is an easy prey. Here comes in the advantage of movable combs, which the owner can inspect. When he finds unmistakable traces of the wax worm he can help out the bees by cutting out the webs and worms with a knife or a stick; but it will be very difficult for him to eliminate all the eggs of the moth which may be scattered all through the hive in cracks and crevices beyond the reach of the bees. The old patent moth-proof (?) hives of early days were full of these cracks and crevices, and, of course, much worse for their propagation than the regular simple hives without moth "contraptions."

In modern apiculture the moth, or more properly speaking, wax worm, can do no damage except among combs which are laid aside for the time being. Combs from colonies of Italian bees will usually

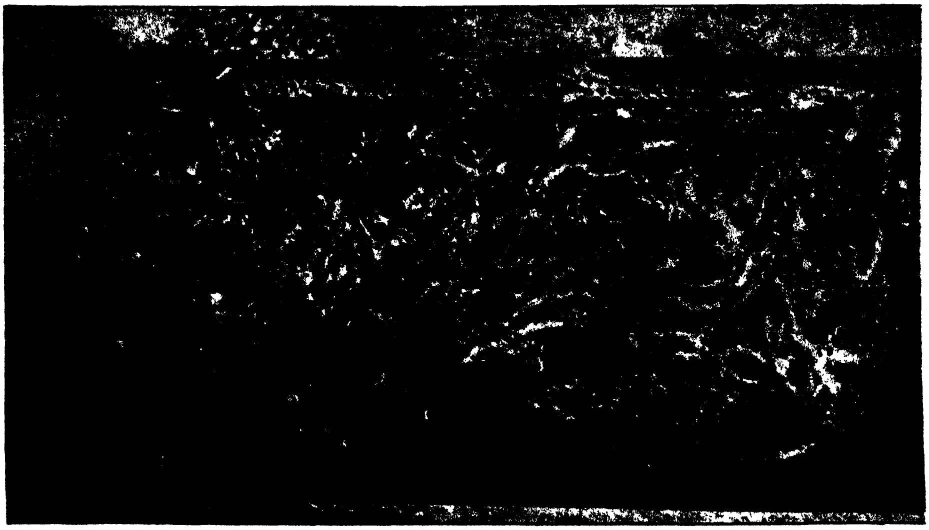
A sample of how the eggs and cocoons are deposited on wood. Sometimes the wood is grooved.

A comb infected by the lesser wax worm, sent by G. W. Tebbs. The webs are finer than with the larger species.

be safe when they are put away in bee-tight extracting-supers or in a bee-tight building.

In this connection combs in unspaced frames—that is, frames without shoulders—are much more subject to damage from the wax worm than those in spaced or Hoffman frames. The former, when put away for the season, are generally put into the super and placed together in close contact. Combs that are spaced like the Hoffman, the ordinary distance apart—1⅜ inches from center to center—are much safer, because they can not be placed in close contact. If they are set 2 inches apart, the damage, if any, will usually be confined to one comb.

It is generally regarded as perfectly safe to take the combs out of the hive right after the season is over, and confine them in hive supers stacked up. If these stacked supers are covered so as to make them bee-tight there will be practically no danger from the bee moth.



The work of the Mediterranean flour moth. Not a wax moth in the true sense.

All combs should be put into supers so that neither the moth miller nor robber bees can gain access to them. Some combs

Cross-secion of a comb infested with the common wax worm.—Texas Agricultural Bulletin No. 158.

will contain a little honey and the first warm day during a dearth of honey these combs, unless put into bee-tight compartments, will invite the worst kind of robbing. Not only this, there will always be danger of the bee moth. Combs confined in bee-tight hives or supers, if they have eggs of the moth in the first place, may develop the wax worm later; but in an Italian apiary this will rarely occur; and even when the moth-eggs are in the comb they will be killed by the first winter freezing. Right here is one explanation of why the bee moth is much more destructive in the South than in the North. All stray eggs or larvae are killed by ordinary freezing weather. Combs stored away in the fall in bee-tight supers will usually be safe if freezing weather follows shortly after. They can also be rendered safe from the moth worm by the use of carbon bisulphide or cyanide, mentioned on page 553.

The Lesser Wax Worm

The work of the lesser wax moth is somewhat similar to that of the larger species; but the galleries are smaller, and the webs are finer and more on the surface of the comb. The photo, by G. W. Tebbs, top page 549, shows the characteristic nest of the lesser wax moth.

There is still a smaller species that infests combs, known as the Mediterranean flour moth. This is not really a wax worm, and its presence is due to the fact that it eats the pollen in the comb; but it leaves in its wake a lot of webs as shown at the bottom of page 549.

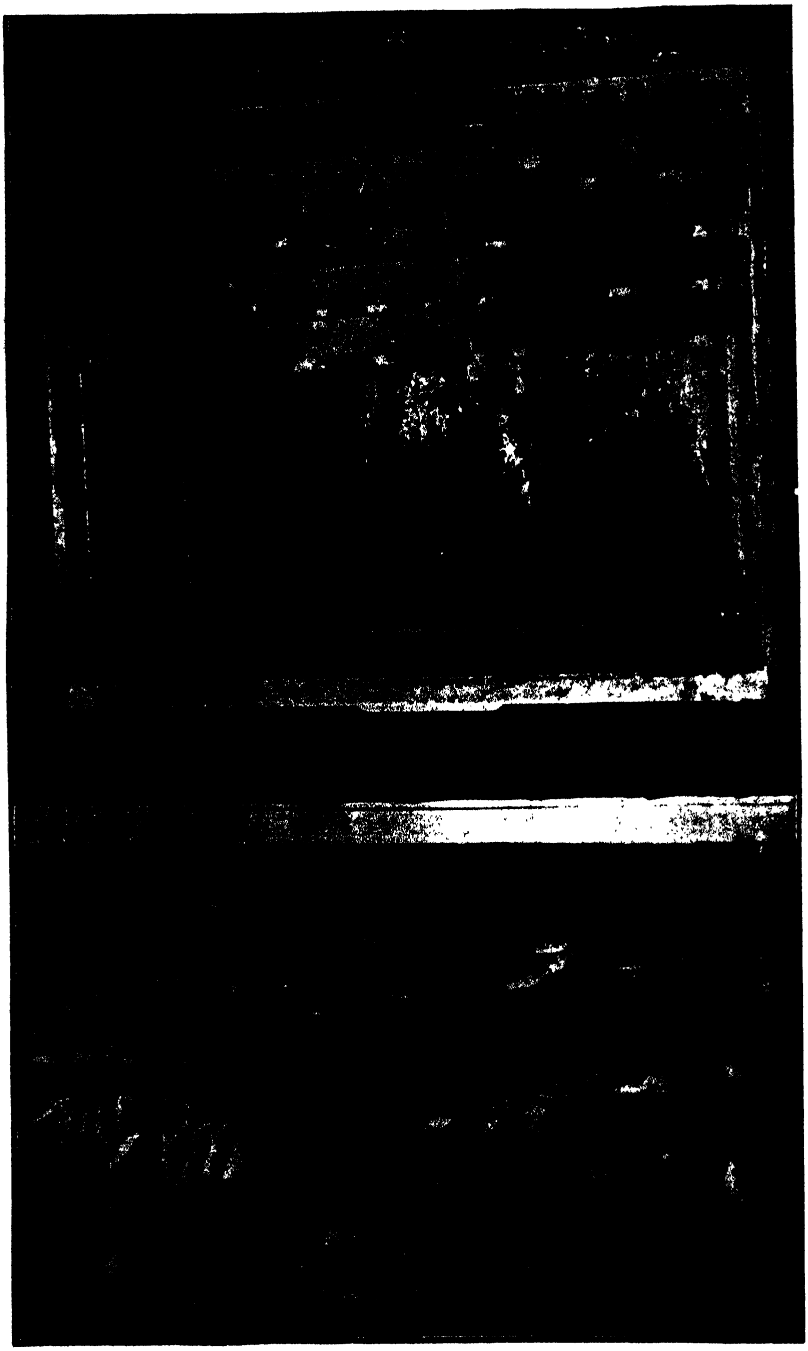
Bee Moth in High Altitude

In Colorado, at least in the region of Denver, where the elevation is fully a mile above the level of the sea, the ordinary wax moths are unknown. The great elevation seems to be more than they can stand. There is, however, a very small wax worm, but it is not the same that ordinarily troubles beekeepers.

The Moth Miller Sometimes a Blessing in Disguise

The moth miller is not altogether an unmitigated nuisance. This pest, as already explained, seldom troubles the professional or up-to-date beekeeper. It is only the slipshod, careless, don't-read-the-papers-class that it visits. Their bees become weaker and weaker, and finally die in the winter, leaving combs more or less filled with honey, and smeared over with the dead matter from foulbrood. Unfortunately, these "old gums" containing diseased honey are a constant source of infection to all the bees in their vicinity. The healthy bees within range rob them out. In the mean time the moth

Life history of the bee-moth: a, moth; b, eggs on comb; c, larvae; d, pupae.—Texas Agricultural Bulletin No. 158.



At the top cocoons of wax moth between the frames. At the bottom cocoons on the end-bars.—Texas Agricultural Bulletin No. 158.

millers, if present, get in their work. Their larvae destroy the combs so that no future swarm will find these old hives a suitable abiding-place. It is right here that the moth miller proves to be a blessing in disguise. These old combs smeared with foulbrood scales would, unless destroyed by some agency, attract bees; for experience has shown that they are frequently occupied by stray swarms. The bees get nicely started in housekeeping, begin to fill the combs with honey and brood, when lo! bee disease begins to make its appearance. The colony dwindles, of course, dies in the winter, and is again the source of infection to the neighboring bees. They rob it out once more; but if there are moth millers in the locality they soon destroy these old combs and leave in their place a mass of webs that is so repellant that no swarm of bees will make a home there. Said one of our Ohio bee inspectors, "The moth miller, after all, may be a friend to the progressive beekeeper in that it destroys one great source of infection—old diseased combs and 'gums' in his neighborhood that might otherwise remain in bee-trees and old hives for years and years, and for years and years spread the disease."

How to Kill the Moth Worm and Eggs in Infested Combs

Where there are one or more hives of infested combs pile them on top of each other on a tight bottom, entrance closed. Put an empty super on top and then pour into a saucer one ounce of carbon bisulphide for every three full-depth supers of combs. Place this saucer of bisulphide in the empty supers on top of the infested combs. Over the whole place a tight-fitting cover. Let the outfit stand for 24 hours. As the bisulphide is heavier than air the fumes will settle all through the combs and kill eggs, larvae, and the moth miller.

In place of the carbon bisulphide some beekeepers in the West recommend calcium cyanide (Cyanogas). This generates the deadly cyanide gas that is destructive to all life. (See page 310.)

The calcium cyanide comes in powder or granular form and as such does not generate gas immediately. This gives the operator time to get away before the deadly fumes can act. A one-pound can of calcium cyanide (Cyanogas) will be enough to destroy all life of every sort in a space of two hundred and fifty cubic feet. As a single ten-frame Langstroth hive-body contains a little over a cubic foot, one ounce will take care of ten hive-bodies. For four hive-bodies containing infested combs one-half an ounce of calcium cyanide would be more than enough.

As in the case of the bisulphide the hives should be kept tightly covered for 24 hours, after which they should be exposed to the air. On lifting the cover when calcium cyanide is used the operator should immediately move away so as not to catch a breath of the deadly gas.

Caution

Bisulphide of carbon (carbon bisulphide) is highly inflammable and explosive. It should be kept away from match or flame. Calcium cyanide generates a deadly gas—deadly to human beings, as well as to bee-moths, ants, bees, and rodents. There is no danger in opening a can of calcium cyanide and pouring out the requisite quantity in a dish or on paper; but the operator, if in a closed room, should get away immediately. When the gas is used to kill the worms in a room, the windows and doors should be closed and locked for 24 hours. The door should not be opened for another 24 hours before entering. Calcium cyanide is often used for killing bees in a hive having American foulbrood before burning hive, combs and all. (See page 310.)

One of the most thorough treatises on the wax moth or wax worm is a bulletin issued by the Texas Agricultural Experiment Station, No. 158, June, 1913. Among other things it discusses the life-history of the bee moth or wax worm. The author, F. B. Paddock, made a very exhaustive study of the larger species, *Galleria mellonella*.

MOVING BEES.—Young bees, when they first start out, or old ones on the first flight of the season after a winter's confinement, hover in the air about the hive entrance, take a careful survey of surroundings, making wider and wider circles, each time taking in new objects by which they may familiarize themselves with the home. When the location is once carefully marked they will go back and forth without taking any note of distinguishing objects. But when the hive is moved only a few feet there is apparent consternation and confusion.

One can not, therefore, move his bees a few feet or a quarter of a mile during the flying season without having the great majority of them go back to the old spot unless treated by the plans here described. Some strains of black bees when moved will find their hives. (See Black Bees, under the head of Races of Bees.) The bees that do not get back perish or possibly get into some other hive near their old location, with the result that there may be a fight, and many bees may be killed.

If one desires to move his bees, and wishes to take them at least a mile and a half or two miles away, the problem is quite easy, for then they will stay wherever they are placed. As soon as they are liberated in their new position they will mark the location as thoroughly and carefully as when taking their first flight.

But to move bees from the front to the back yard, or from a fourth to half a mile, is not so easy. They are familiar with the whole range of flight within a mile of the old stand; and when they go over their old hunting-ground, so to speak, instead of returning to the hive from which they have just come they will return to the old location. How, then, shall we make them stay where placed? One way, and the very best one, is to wait till fall or winter. After they have quit flying for the season, move them to the spot desired. If they are confined a month or more by cold weather, they may mark their new location and go back to it as their regular and permanent home. It will be better still if they can be confined for several months in the cellar; then, when put out in the spring, they should be placed in the new location; for it is well known that cellared bees can be placed anywhere the following spring without reference to their old stands. Wherever they are placed they will mark their location, and that must be their fixed position for the season.

But suppose it is the midst of summer, and for some reason the bees must be moved a few rods from their old lcoation. Perhaps complaint is made that the bees in the front yard are interfering with passers-by, and to avoid trouble it seems desirable to move them to the back yard. In an emergency of this kind the following plan may be used:

Tack wire cloth over the entrances, carry the hives down cellar, and keep them there for at least five days, and longer if they appear to be quiet. While the bees are in the cellar, change the surroundings in the front yard or in the old location as much as possible. After the bees have served out their alloted time of confinement, put them in the back yard in the same order as before if it can be done conveniently. While some of the bees will go back, the great majority will stay in their new location. Those that do return should be given a frame of brood in a hive; and when they have clustered on it they should be taken to the new location and dumped in front of the entrance to the hive. If the bees are confined during cool or rainy weather when they can not fly, there will be no loss of honey that might be gathered from the field. While the bees are confined in the cellar a sharp watch should be kept on them to see that they do not suffocate; and, if practicable, the whole top of the hive should be covered with wire screen.

There is still another and very much better method; and that is, move the bees to a point a mile and a half or two miles from the old location. Let them stay there for the season, then move them back.

Another plan that has been spoken of very favorably: In the cool of the morning, at a time of year when no honey is or has been coming in, colonies may be moved a few feet or a few rods with very little trouble. The hives are put on a wheelbarrow early in the morning, and after smoking at the entrance are trundled as roughly as possible clear over to the new location, for it is important that the bees get a general shaking-up in moving. If the frames are self-spacing there will be no damage done to the combs nor to the bees. The hive is set down on its new stand, when it is given a little more smoke. Any number of colonies can be moved in this way; but the moving should be done at once, and the old location should be changed in appearance as much as possible. Very few bees will go back when so treated. The author has tried it in a limited way, and found that it works admirably. The bees should not be moved a short distance when a honey flow is on or has been on for two or three days. When they have been going regularly to the fields for a number of days they get their location well fixed, and it is almost impossible to move them short distances at such times without a general returning of field bees to the old stands. A corre-

spondent reported that he attempted to move bees to a neighboring lot when the honey flow was on, and he says he never saw bees crosser in his life. When, therefore, a neighbor complains that the bees are interfering with public traffic along the highway, and they must be moved at once, one must take into consideration whether there is a honey flow on. If so, move all the bees at night to a location a couple of miles away. (See Bees as a Nuisance; also Apiary.)

The author tried another plan that has given good results; but this, like the other, must not be attempted when a honey flow is on. Move the hive a few inches a day, and each time make a bigger jump than the one preceding. After the bees have been moved in this way from two to five times they learn to expect a change in location, and therefore will hunt out their hive wherever it may be. Sometimes in such moving it is advisable to put up a board against the entrance just after moving, in order to arrest the attention of the bees when they come out. This forces them to mark their location anew.

How to Move Bees a Distance of Several Miles

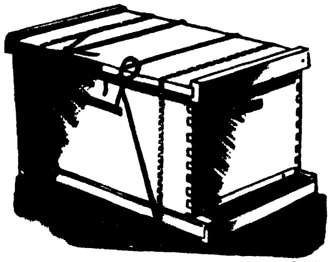
The remarks that have been made heretofore apply to moving bees only a short distance; but when they are to be carried a considerable distance, and jolted over rough roads, they require more ventilation than can usually be offered by an ordinary entrance. If they are shut up during the middle of the day, those in the field are liable to be lost. Ordinarily they should be confined at night or in the early morning—better at night unless the weather is hot.

If the bees must be moved during the middle of the day, a hive with a comb of brood should be left on the old stand, when the owner can start a nucleus very conveniently with the returning bees.

Most beekeepers fasten the bottoms to their hives permanently, so all that is necessary in such cases is to secure the cover and put a wire-cloth screen over the entrance. If very warm a screen should also be used over the top. A very good plan during cool weather is shown top of next column, consisting of two cords or ropes.

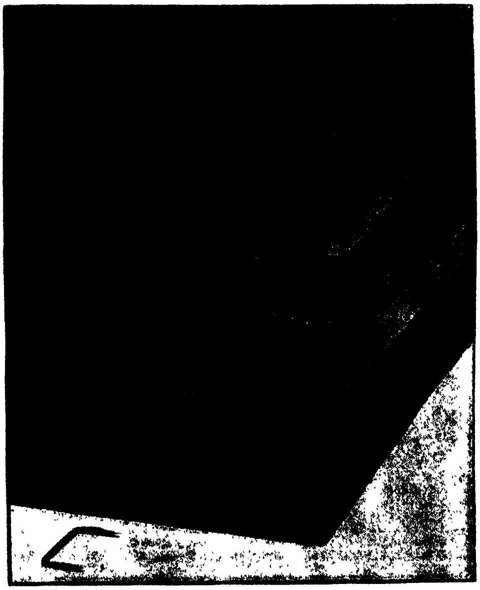
One rope is drawn around as tight as possible at one end and the other is put on the other end. The cords are then drawn together at the top in such a way as to produce a strong tension.

Another plan, somewhat similar, is to use one cord or rope. It is drawn around



the hive, and tied loosely. A stick is then slipped into the cord and given a half-twist in such a way as to draw the loop up very tight.

But by far the most satisfactory plan, certainly the safest, and one the authors adopt in their moving, is that of using a special staple (obtained at the hive factories) shown in the accompanying illus-



Removing staple used for fastening hive bottom.

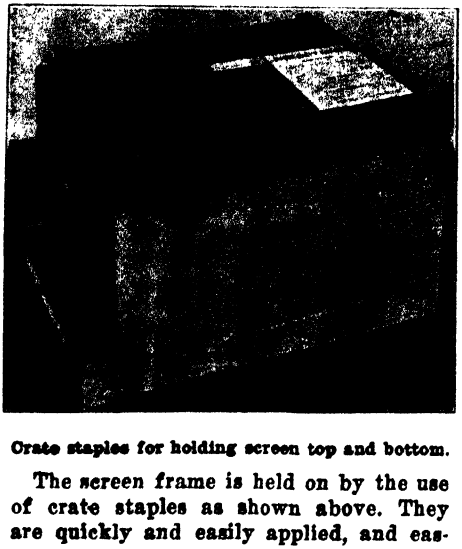
tration. One leg of the staple is driven into the bottom-board, and the other into the hive-body. Two staples on each side will be sufficient to hold the bottom-board. The cover is fastened in the same way. The staples are very easily removed with a screwdriver at least a foot long, if they are not driven down too tight. The tool is shoved under one side,

close to a leg of the staple, and given a quarter twist; then it is moved over to the other side, and twisted again. When the staple is raised high enough so the screwdriver can get under and give it a good pry it can be easily removed.

Preventing Bees from Smothering

In the early part of the season, in the spring or fall, or any time when the weather is cool, it is not necessary to have any more ventilation than will be secured with an ordinary entrance covered with wire cloth. As the weather warms up, additional air will have to be provided. Sometimes this can be secured by taking pieces of section ⅛ inch thick, and placing one at each of the four corners between the hive and cover. The latter should be secured by ropes or staples, as previously shown. This makes a crack all around ⅛ inch wide, but not quite wide enough to let bees through.

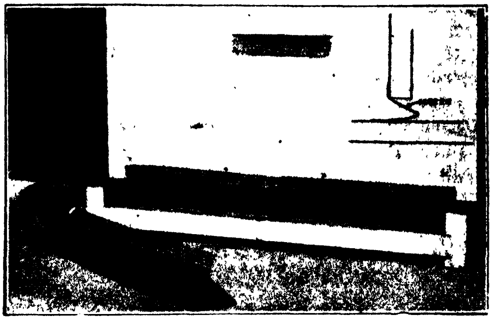
A far safer and better arrangement is to use wire screen in place of the cover. A wooden frame 1½ or 2 inches deep should be made of ⅞ lumber, the same length and width as the hive. A piece of wire cloth large enough to cover it is tacked on, and over the marginal edges are nailed strips of wood ⅞ inches wide and ½ of an inch thick. The purpose of the ½-inch strip is twofold—to help hold the wire cloth in place and raise the next hive that may be piled on top crosswise at least one-half inch above the wire cloth.



Crate staples for holding screen top and bottom.

The screen frame is held on by the use of crate staples as shown above. They are quickly and easily applied, and easily removed with a screwdriver. It is alway advisable to use wire screens in moving bees during hot weather. It is hardly safe to depend on the ventilation at the entrance or through narrow ⅛-inch slots between the covers and hives.

When hives of bees are loaded on to a wagon or truck they should be placed in such a way that ventilation through the top screen will not be shut off. In the case of an ordinary hayrack the hives may be spread out over a large surface in the bottom of the wagon and over the rack. In this way it will not be necessary to pile one hive on top of another.



Screens bent in this shape can be wedged into the entrance. No tacks are needed except for long hauls.

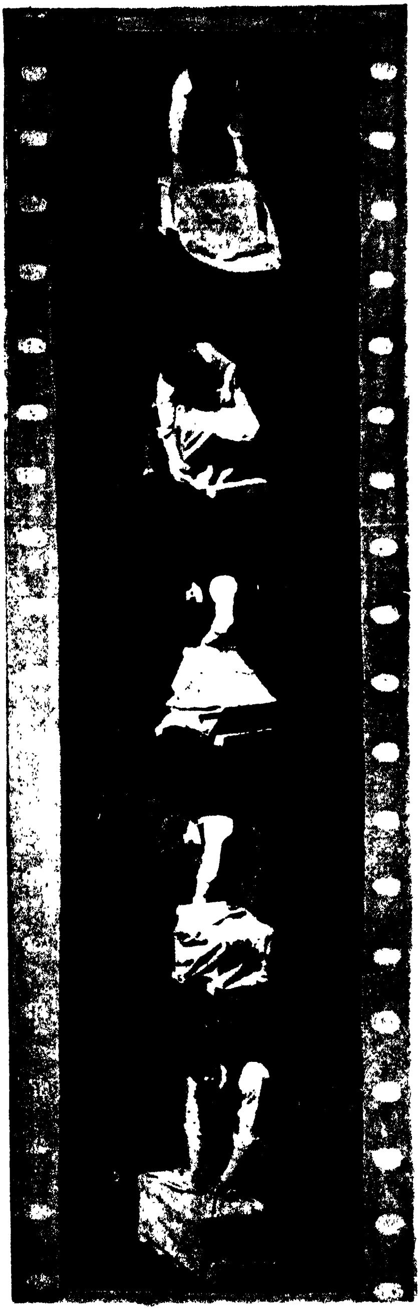
The most satisfactory entrance-closer is a piece of wire cloth, the length of which is the inside width of the hive, and in the form shown above.

This is easily placed in the entrance of the hive by tacking the upper right-angled piece against the upper part of the entrance.

The main feature of this is that it holds its place without any tacks, although one or two are needed to prevent its jolting loose when on the automobile truck or wagon. Moreover, the angle that projects into the entrance increases the amount of ventilation just in proportion as more wire cloth is used.

Sacking Bees

Where hives are old and full of cracks, putting screens on top and at the entrance would do little good. In such cases, one can use second-hand burlap sacks of a size large enough to take in a whole hive. One of these can be slipped over a hive and tied in much less time than it takes to put on screens. The mode of procedure is shown step by step on the next page.



Above is shown stage by stage a method of sacking bees for moving. The exact mode of procedure is shown in the order of the pictures, reading from above down. Where the hives are old, especially if they are full of cracks, or the cover does not fit tightly, this plan of moving bees is ideal. Even if the hives are good, it is probably cheaper than the entrance-closer and a hive screen over the top. To sack a colony is a matter of seconds only.

Where one can secure a quantity of large burlap sacks without holes in the sides this method of shutting in bees can be used on good hives as well as old ones. The same sacks, of course, can be used over and over again. The author has helped move bees in sacks over rough roads without a single bee escaping. There is no danger of the bees suffocating, because they can crawl into the sack.

Loading an Auto Truck

When using an automobile truck, where hives have to be piled on top of each other, an open framework of 2 x 4's should be placed between the several tiers of hives. Without some scheme of keeping the hives apart, the bees in all except the top tier of hives would smother.

Moving Bees by Truck or Wagon Without Shutting Them in the Hive

This can be done very often without the necessity of using wire screens at the top, nor even entrance screens. Before the hives are loaded, smoke is blown into the entrances to prevent the bees rushing out and stinging when the hive is disturbed. Just before the start is made the entrances are smoked again. The subsequent jolting over the roads, so far from making the bees ugly, quiets them. If the weather is exceedingly warm the bees will crowd out and cluster round the front of the hive rather than smother.

The objection to this plan is that some bees get out all over the hives. For this reason it should not be used with an ordinary horse-drawn wagon. It has the further disadvantage that there will be a lot of flying bees around the hives, some of which will be lost as the truck moves forward. But when one is not provided with screens of any sort he can very often pick the bees up, put them on the auto truck, and land them at the outyard without any further trouble.

When to Load Bees

No bees should be loaded on a wagon or truck during the middle hours of the day, since many field bees would be lost. They should be loaded very late in the morning while all the field bees are in. The hives may be made ready at night, and the bees may be moved any time the following day, although on account of rising temperature they should be started as soon as possible. In warm weather it is better to move at night after all the bees are in.

Shipping Bees Long Distances by Express During warm weather it is advisable to have the shipping boxes or hives with wire screen at bottom as well as top. The express agents are usually careless, and, in spite of instructions to the contrary will leave bees out in the hot sun or in a small express room with all kinds of packages piled on top. For that reason additional ventilation should be provided. Provision should be made to protect the bottom screen and insure ventilation at all times. If unspaced frames are used they should be secured by notched cleats.

On top of every shipment of bees there should be a label cautioning agents against leaving the bees out in the hot sun or piling anything on top of them, thus shutting off the ventilation; that bees are perishable property, and should be moved without delay, and that on arrival at destination the owner should be informed by telephone or messenger. For moving or shipping bees without combs, see Shipping Bees, Package Bees, and Beginning with Bees.

MUSTARD (*Brassica arvensis*).—Many species of the mustard family are extensively cultivated for seed, and in the vicinity of large acreages of any of these plants it would doubtless be profitable to establish apiaries. But unless the crop of seed will pay the expense of cultivation, it would not be advisable for beekeepers to plant any of the mustards for honey.

The bees work alike on both the yellow and red varieties, indicating that there is no difference in the amount of nectar secreted. The period of flowering lasts about a month; and where the sowings are made at different intervals it can be prolonged for a period of ten weeks. The honey is mild in flavor and light in color, and commands the same price as sage. (See "Honey Plants of North America.")

N

NECTAR.—Green plants, through the activity of chlorophyll in the presence of light from the sun, have the ability to transform carbon dioxide and water vapor from the atmosphere into carbohydrates, primarily sugars. This is an elaborate chemical process, the details of which need not now concern us. In any event, it is known that by this process sugar is formed in green leaves and in stems of plants. Sugars thus formed are easily soluble in water and form an important constituent of the plant sap, so that they are thus transported to all parts of the plants, either to be used immediately as food or to be stored for future use. If used immediately, the sugar again soon becomes carbon dioxide and water vapor, these being the final products of sugar combustion or consumption. Too concentrated a solution of sugar would produce such a powerful osmotic pressure that plant tissues would be destroyed, so that it is a valuable provision of nature that excess sugar may be stored in the form of inert starch. Starch may in turn be transformed back to sugar, enter plant circulation and serve as plant food. If the plant is used as food by man or some animal, the sugar or the starch of the plant serves as animal food.

When the flower is ready for fertilization preparations are made for future needs. Immediately after fertilization occurs an exceedingly rapid growth begins in the ovaries of the flower; and, in anticipation of this need for easily utilized food, practically all flowering plants concentrate a quick food supply at the bases of their flowers for this purpose. But here, also, too concentrated a sugar solution would damage the flower, so means have been developed for eliminating this danger. One common method is for the flower to secrete the excess sugar which is transported to this part in the circulation. If this occurs at the base of a flower, which is the part of any plant where such secretion is most probable this secretion is called nectar, it being

the raw material from which bees elaborate honey.

In those plants which regularly secrete nectar, special organs called nectaries have been developed, thus facilitating the elimination of excess sugar and providing a regular place from which the bees can gather it. In other plants, in which nectar secretion is only occasional, no nectaries are found, but sugary materials may be eliminated through the ordinary stomata on the surface of the plant tissues. This occurs more frequently at the bases of flowers than elsewhere, but also occurs on leaves, stems, and, in fact, on almost any part of some plants.

Every beekeeper knows that honeys from different plant sources vary in color, flavor, tendency to granulate, and in many other ways. In general the work of bees in ripening nectar to honey is the same for all nectars, so from this it may be concluded that nectars differ as much as do the resulting honeys, and this is found to be the case in the relatively few analyses of nectar which have been made by chemists. The larger part of our information on nectars must come from our knowledge of the honeys made by bees from these varying products.

Water Content of Nectar

The water content of nectar is usually higher than that of honey. Well ripened honey contains twenty per cent of water or less, depending on the thoroughness of ripening, climatic conditions, and other factors. Every beekeeper who has kept a colony of bees on scales knows that if a colony makes a gain in weight of fifteen pounds during a good gathering day there will be a considerable decrease in weight during the following night. This decrease is not due solely to the evaporation of water, but is partly due to the fact that the bees and their brood are constantly consuming honey, which results in a decrease in the weight of the hive; but during the season of the honey flow this consumption of honey is only slightly higher than during other parts of the active season. The loss of weight in a strong colony may equal a third of the gain of the preceding day, which indicates that the nectar gathered may have contained as much as fifty per cent water. It is unnecessary to go into the complex calculations from which these estimates are derived. Estimates and statements have been made to the effect that nectar often contains eighty per cent water, but this is exceedingly rare. Certain analyses of nectar do show an exceedingly high water content, but this is unusual in the United States and never occurs in the dryer parts of the country, where nectar may be evaporated without the intervention of the bees to a high concentration of sugar.

Not only is the water content of nectar changed by the ripening of honey, but changes also occur in the solid material. It is sometimes erroneously stated that the sugar in nectar is chiefly or solely cane sugar, but this is not supported by analyses.

The Sugars in Nectar

Miss Ruth Bentler, of Germany, published an article in the report of the Society of Morphology and Physiology of Munich, Germany, in which the results of chemical analyses of certain nectars are given. The nectar was collected by hand in pipettes and transferred to containers for immediate analysis, the nectars of plum, paradise apple, horse chestnut, thermopsis, imperial crown (Fritillaria), and two species of milkweed and honeysuckle being examined for total sugars, cane sugars, and reducing sugars. Horse chestnut, or buckeye, is credited with the remarkable sugar content of 75.2 per cent, nearly all cane sugar, while imperial crown had but 10.1 per cent sugar. A very great variation in sugar content is noted in Table I.

TABLE I.

	No. of nectar samples tested.	Pct. dry matter.	% reducing sugars before hydrolysis.	Pct. cane sugar.	Pct. total sugars.
Plum	12	36.6	16.5	15.97	32.47
Paradise apple	4	42.6	23.7	24.76	48.4
Imperial crown (Fritillaria)	9	8.2	9 4		10.1
Horse chestnut	15	70 0	2.5	72.2	75.2
Thermopsis montana	8	53.6	20.4	29.8	50.1
Milkweed, Asclepias cornuti	18	27.2	2.0	25.9	27.9
Milkweed, Asclepias currassavica	3	20.3	1.7	18.6	20.3
Honeysuckle, Lonicera caprifolium	11	24.35	5.8	(20.4) ?	?
Honeysuckle, Lonicera heckrotti	14	26.8	5.1	(17.5) ?	?

A study of variation in the sugar content of nectars with degree of humidity and soil moisture was attempted. A marked increase in amount of nectar was observed during rainy weather, accompanied with a decrease in percentage of sugar content. Abundant soil moisture gave virtually the same effect as high

humidity. Table II shows nectar content changes.

TABLE II.

	Normal dry substance.	Normal sugars.	Mg. from one flower normally.
Plum	36.6	32.5	1.19
Asclepias	27.2	27.95	
Horse chestnut	70.0	75.2	1.23

	Dry subs. during rain.	Sugars during rain.	Mg. from 1 flower during rain.	Loss during rain	
				dry subs.	sugar.
Plum	15.3	15.6	5.23	21.3	16.9
Asclepias	8.8	7.9		18.4	20.1
Horse chest.		49.1	1.30		26.1

The nectars examined by Miss Beutler all showed more or less acid, with the exception of plum-nectar, which gave an alkaline reaction. The reactions of *Asclepias cornuti* (a milkweed), studied with reference to acidity, fluctuated somewhat, although always of highly acid values.

The term reducing sugars is used to include grape sugars (dextrose) and fruit sugars (levulose) because of certain chemical properties that they have in common.

Enzymes in Honey

Bees produce in great quantities and in various parts of their bodies a material known as invertase (see page 442), which has the power to break cane sugar into its constituent sugars, dextrose and levulose. When nectar enters the honey stomach in being transported to the hive, invertase is doubtless added to it immediately and the change of the sugars begins at once. More invertase is probably added in the later ripening processes, and all the invertase remains in the nectar and honey throughout the stay in the hive, continuing to act, if there is cane sugar present on which it can act. For this reason the change of sugars does not all occur immediately, but may continue even for weeks. Some cane sugar may even remain unchanged in honey, the amount never exceeding eight per cent under the limitations set by the Federal Bureau of Chemistry and Soils. Most honeys contain smaller percentages than eight, an average being less than two per cent.

There are other interesting materials also present in nectar. During the transformation of sugars to starch or of starch to sugars an intermediate stage of complexity is reached and the materials then present are called dextrin. It has been found that bees can not change dextrin, and since these substances occur in ripened honeys we may be sure that they come from the nectaries of the plants, unmodified by the bees. They must then occur in nectars. Dark honeys, as a rule, contain the higher proportions of dextrins, with the exception of buckwheat honey, which contains little or none when pure and unmixed with other honeys. Other higher sugars may occur at times in honeys and therefore in nectars, such as the sugar alcohols mannite and dulcite and the rare sugar melezitose.

Mineral Content

A discussion of the carbohydrates of nectar by no means exhausts the supply of materials which are known to occur in nectar. The mineral constituents of honey come through from the nectar unchanged, and finally constitute an important part of honey in determining its value as a food. The coloring materials of honey are derived solely from the nectar, since every beekeeper knows that the colors of honeys vary with their plant source. These coloring materials are plant dyes or colors exactly of the same nature as are seen in flowers and other colored parts of plants. The flavors of honey are also variable and differ according to the plant from which the nectar is gathered, so that from this fact it is known that these minute quantities of materials which make honeys so good to the human taste are derived through the nectar and are present in nectar. (See Honey, Mineral Constituents of.)

It has already been stated that bees produce invertase and that they place this in the nectar during ripening. The invertase is not at all used up in the ripening process, but remains in full strength in the honey. This can be shown by the fact that honey will continue to invert cane sugar after removal from the hive, provided the invertase is not destroyed by the heating of the honey in bottling. We then have an enzyme in honey which has its origin in the bee, or which at any rate may partially be produced by the bees and added to the nectar. There is some reason to believe that invertase may also occur in the nectar as secreted by the flowers. Other enzymes occur in honey which are certainly not derived from the bees. For example, diastase (the starch-splitting enzyme) has been found in many honeys, and this is an enzyme which does not occur in bees, so that it must enter the honey from nectar itself. A few other enzymes occur in honeys, at least some

of which are found in nectar before the bees gather it. (See Honey, Enzymes in.)

Nectar is, then, not at all a mere solution of sugar, as sometimes has been stated. It is a highly complex material, serving a most useful purpose to the plants themselves. If secreted by the plants, it may be gathered by the bees, modified for storage by the change of the sugars and the elimination of water, used by the bees for food and for feeding their brood, and stored by them against periods of adversity. Later on man may come along and take some of this for his food or for sale, but man gets only a small part of all that is gathered by the bees as nectar. We may then state that nectar contains considerable water, several sugars, mineral materials, acids, coloring materials, flavoring materials, enzymes, colloids, and doubtless other materials still to be discovered.

A catalog of the materials in nectar by no means exhausts the points of interest about it. Nectar is in large part a solution of sugars, in most cases not holding as much sugar as the water can retain in solution. The bees at once begin the elimination of water when they bring nectar to the hive, but bees do not stop their work in eliminating water when the solution is saturated. Honey is a supersaturated solution, often remaining in solution for weeks and months after extracting. It is thus seen that the bees carry their elimination of water farther than man could easily do. Nectar will easily ferment, whereas well-ripened honey does not ferment so long as it remains liquid, fermentation occurring most frequently in granulated honeys. The ability of bees to produce a supersaturated sugar solution is due in large part to the materials occurring in nectar which they gather. It is, for example, known that if the ash is artificially removed from honey, sugars are at once thrown down because the balance of the solution has been disturbed. It then appears that almost every constituent of nectar is important in enabling the bees to produce their delicious product, honey.

Honey differs from refined sugars and artificially manufactured sugars chiefly in the presence of small quantities of important food constituents rather than in differences in the sugars. These materials found in honey in small amounts, but still such highly important quantities, are derived from nectar and are found in nectar, with the possible exception of invertase added by the bees. It is scarcely fair, therefore, to speak too strongly of the making of honey by the bees, since so much comes to them ready-made. (See Honey, Honey, Acidity of, Honey, Enzymes in, Honey, Mineral Constituents of.)

As to conditions favorable for the secretion of nectar see Secretion of Nectar.

NUCLEUS.—This word, when applied to bee culture, means just what the name signifies — a small colony of bees. It may mean a hundred bees with a queen, and as such it is called a small baby nucleus; but so small a number will not long survive without help. The term "baby nucleus" more properly means a larger force—anywhere from five hundred to a thousand bees with a queen—a force large enough to set up housekeeping in real earnest. Baby nuclei are used extensively by commercial queen-breeders. (See "Modern Queen Rearing," by Pritchard, and "Queen Rearing Simplified," by Smith.)

Generally speaking, the word "nucleus" signifies one or two full-sized frames of bees, either in a full-sized hive or one just large enough to hold two frames and no more. When it has five or six frames of bees and brood it is usually called a light or a weak colony.

These small aggregations of bees must be built up to full-sized colonies in order to make them useful for honey production; for it requires a colony of not less than two eight or ten frames in size to produce honey. While a two or three frame nucleus will furnish a little extracted honey, the amount that it will produce in comparison with a large colony is relatively small. Or, to put it another way, ten two-frame nuclei will produce only a fraction as much honey as one two-story ten-frame colony. How to build up these nuclei into colonies so they will be of some use is fully described under the head of Building Up Colonies, Increase, Dividing, Brood and Brood-rearing.

Nuclei are used for one of two purposes—for making increase and for the mating of queens. It is a waste of time and bee force to have virgins mate from a full colony. While cells should be raised in such colonies, the queens should be mated in miniature hives having anywhere from five hundred up to one thou-

sand bees. (For particulars regarding this phase of the subject, see Queen-rearing.)

Nuclei may also be useful for the purpose of instruction. A beginner can handle a light force of bees much more freely than a big colony. The small babies or the two-frame nuclei can be manipulated by the average A B C scholar very easily. Queens can be introduced much more easily than to the large stocks. As the nucleus grows in size, the beginner who is constantly watching them grows in experience; and by the time the colony reaches the full size he is perfectly capable of handling it, provided, of course, he has read the articles on A B C of Beekeeping, Manipulation of Colonies, Stings, and Robbing.

Forming Nuclei for Increase

As already explained, dividing colonies into nuclei for increasing the number of hives containing bees is usually a mistake if honey is the object. But after the main honey flow, increase can be made by splitting up the colonies into units of two and three frames, supplying each with a cell, virgin, or laying queen. The process appears to be much simpler than it really is. The question often comes up in the mind of a beginner, "What can be easier than to take a ten-frame colony and divide it into five two-frame nuclei on as many hive-stands?" If the bees moved from the parent stand would stay where placed, the problem would be very much easier. Unfortunately the old field bees, especially right after a honey flow, will go back to the parent stand, leaving nothing but the young bees to take care of the brood, which, in a great many cases, is neglected and dies. This is not all. Robbers, during a dearth, will be ready to invade the entrances of these deserted nuclei with just a few young bees; and before Mr. Beginner knows it he has a perfect uproar, the loss of some thousands of bees, and perhaps trouble with the neighbors on account of robbers smelling around the entire neighborhood after they have wrought havoc with the nuclei. (See Robbing, subhead, Robbing of Nuclei.)

If the beginner buys a colony of bees from some farmer or beekeeper two or three miles away he can bring it home and make the divisions before the bees mark their location, and the bees of each nucleus will stay where they are placed. This will effect an equal division, and everything will be easy, provided, of course, that the entrances are contracted and the beginner uses ordinary caution. At the time the nuclei are formed, each should be supplied with a cell, virgin, or a laying queen. If it is desired to make increase rapidly, the nuclei will make greater progress when supplied with laying queens. If it is desired to let each nucleus raise its own queen, precaution should be taken to see that eggs or very young larvae are in each nucleus; but it should be understood that the progress will be very much slower, and that queens reared in nuclei are never the equal of those reared in strong colonies.

It is not wise for a beginner in the northern states, to make a division after the middle of July or August. If he splits his colonies up into halves, the problem will be very much simpler. In the morning he should remove about two-thirds of the bees, all sealed brood, or as much as possible, and the old queen, to the new location, leaving the unsealed brood and about a third of the bees on the old stand. The latter should be given a cell or virgin. Most of the flying bees will return to the old home, making the division somewhere near equal, with the chances that the old hive will have the larger force of bees in 24 hours. But the split-off, or nucleus, on the other stand, will have all the sealed brood and emerging brood, and will soon be more than able to match forces with the old colony. The old queen, which will act as an attraction to hold the bees in the parent colony, will soon supply it with eggs and young larvae as fast as the bees can take care of it or as fast as the brood emerges.

In a similar way three colonies can be made out of one; but most of the sealed brood and most of the bees should be given to the nuclei on new stands, always keeping in mind that most of the flying bees will return to the old stand. If, however, the entrances are kept closed for three or four days there will not be so much returning. Of course, the nucleus on the old stand will not need to have its entrance closed. If it is discovered that one of the nuclei, or both of them, are short of bees, a frame or two of bees from some other colony can be shaken at night in front of the entrances of the nuclei on new stands. When doing this, it may be advisable to cage the queen for a day or two.

Somerford Method of Forming Nuclei

W. W. Somerford described a method of forming nuclei that has worked very satisfactorily, especially when the work is done at outyards. While it involves some of the principles already described, it is enough different to warrant giving it a place here.

To begin with, in all your fancy stock remove the queens or cage them, after getting the brood-nest well filled with brood (the more brood the better—8 or 10 frames in a hive if possible). Wait ten days after removing the queen, when the bees will generally have cells on every comb, and be in a broody or listless condition, waiting for cells to hatch. Divide and remove the frames quietly, giving each new hive two frames of brood and all adhering bees, and one good frame of honey, using it for a division-board (and, by the way, such division-boards are to my notion the best in the world); put the two frames of brood and bees next to the wall of the hive, and let the honey-frame be the third from the side of the hive. Be sure to see that you have at least one good ripe-looking cell in each new hive, or division, and don't forget the frame of honey. As soon as each division is made, stop the entrance of the hive by stuffing it full of green moss. If you haven't any green moss, use green grass or leaves, and be sure to stuff them in tight—as tight as though you never intended the bees should gnaw out, and be sure there are no cracks or holes that a single bee could get out at; for it there are, your division will be ruined by all, or nearly all, the bees that can fly leaving it. Each parent colony should make four or five good divisions that will make booming colonies in 40 or 50 days, and I have had them the best in the apiary in less time. Leave or loose the old queen (if not too old) on the old stand, and the bees from it will work straight ahead, as they don't have to be confined to make them stay at home.

Don't be uneasy about the divisions that are stopped up, unless you failed to stuff the entrances well, for they will not smother, but busy themselves gnawing at the moss or grass for two or three days, possibly four or five, if you have done an extra good job at stuffing the entrance. At the end of that time you will find they have all gnawed out so as to secure egress and ingress. Then you can move enough of the grass or moss to give them a clean entrance, 1½ to 2 inches wide; and by looking into them you will be astonished at the quantity of bees you have in each hive (and they too, well satisfied), having consumed so much time in gnawing out that the queen had time to hatch and kill off her rivals and be ready for the wedding trip by the time the entrance is cleaned. So, instead of in a week's time having a worthless weak division with a chilled inferior queen, as is the case in the old-style way of dividing, where nine-tenths of the bees return to the old hive, you have a strong vigorous queen and a nice little satisfied swarm of bees, ready for business in the way of pulling foundation before they are three weeks old.

I have succeeded with 19 out of 20 divisions made in the above way, when I did not even see them until the third week after dividing as above; and for the average beekeeper who has out-apiaries I think there is no better way in the world to make increase.

In the above method of increasing, you have no queens to buy, no robbers to bother with, and but little time lost, as an expert can make 20 divisions an hour.

Navasota, Texas.

In the first paragraph, Mr. Somerford mentions removing or caging the queen. It should be explained that usually any queen can be caged in her own hive for a week at a time, and her bees will take care of her through the wire cloth. If a queen is removed entirely it is implied that she is to be caged in another hive, or introduced. She may, however, be put in a cage supplied with queen-cage candy, and kept for a week or ten days in a warm room. But there would be danger of losing her, as she might die, because, under artificial conditions, she can not get the "balanced rations" that she needs to keep up her bodily functions.

Another plan of making two colonies out of one is given under the head of Dividing, for the production of honey and at the same time securing increase. (See page 229.)

One-comb observation hive showing the relation of comb to sections in the hive.

OBSERVATION HIVES.—The origin of hives with windows or transparent sides is lost in the mists of antiquity. In very ancient times pieces of transparent substances such as horn, isinglass, mica, etc., were let into the sides of the hives that the work of the bees might be observed. Such windows, however, afforded but meager opportunity for studying the behavior of the bees in the hive. The first approach to the modern type of observation hive was invented by W. Mew, of Easlington, Gloucestershire, England, about 1650. This appears to have been but little more than a hive with glass windows. At about the same time, John Thorley, of Oxon, England, put bees in a bell glass and used bell glasses as surplus chambers on his hives. No practical advance was made from this until about 1730, when Reaumur, the eminent French naturalist, established a swarm between two panes of glass. These panes were so far apart that the bees could build two combs between them, hence much of the work of the bees and queen was hidden. Bonnet, the Swiss naturalist, recommended a hive with "doors" only so far apart as to permit the bees to build one comb between them; and Huber, about 1790, adopted this suggestion and the result was the wonderful advance which he and his faithful assistants, his wife and his servant Burnens, made in the knowledge of bee life. From that time until the present, little change has been made in observation hives, except in so far as the use of movable-comb hives changed the methods of stocking them.

The usual type of observation hive con-

sists of a single-comb hive with glass panels with ventilating wire-screen strips below the glass. This is important. Sometimes there is a row of sections on top to show the relative position of the sections and the brood-nest while they are being filled by bees in the regular way. See illustration. Of course, it would not be possible to produce section honey in a single-frame nucleus; but when an observation hive with sections is displayed in a window where honey is on sale it not only attracts prospective buyers but it educates them, in that it shows a part of the brood-nest with the bees and the brood, and the sections of honey just as they are on the hive. It advertises honey as nothing else does. Great crowds congregate on the street watching the bees on the comb "making honey." (See Marketing Honey and Honey Exhibits.)

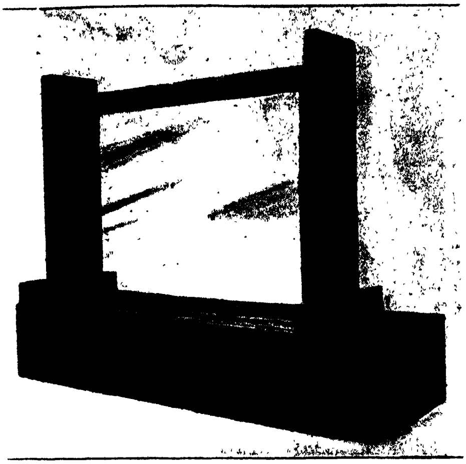
Observation Hives for Scientific Study

The single-comb hives can be studied to good advantage in the home or in the school. In either case they are placed on a shelf on a level with the window sill so that the entrance will pass under the window sash. The space on each side is closed with a stick. The bees will set up housekeeping, go to the fields, and enter upon their ordinary work as though there were no one on hand to see.

Sometimes an observation hive can be placed some ten or twelve feet from the window or side of the building. In that case a tube connects the hive to a hole through the side of the building. (See Honey Exhibits, pages 448 and 449.) Strange as it may seem, the bees will learn to go through this long tube to the outside. At the San Francisco Exposition in 1915, and at the Century of Progress at Chicago in 1933 and 1934, an observation hive was arranged in this way, and the bees used this long tube entrance the entire season. (See page 450.)

Where nature study is being taught in schools these observation hives are used to a considerable extent; and very often beekeepers themselves who desire to become more intimately acquainted with the habits of the bee find pleasure and profit in keeping one of these hives up next to the window of the living-room.

When the bees come in with fresh loads of pollen or new honey they show the usual signs of rejoicing by shaking their bodies, apparently to attract attention and thus induce other bees to find the treasures that they have brought home. (See Joy Dance, under Bee Behavior, page 66.) A great many other interesting things can be discovered with one of these hives where the comb is parallel with the glass panel. But what transpires in the cells and behind the cappings can not be determined with this kind of glass hive.

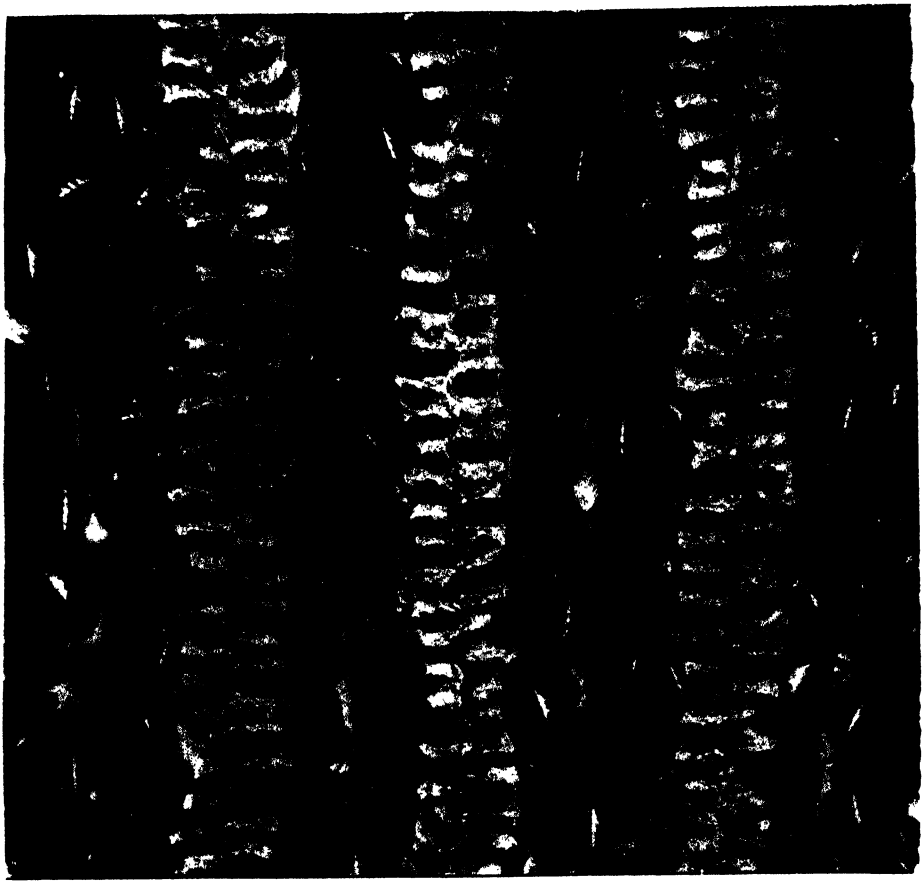


Miller's observation hive without the crosswise combs.

Arthur C. Miller, of Providence, R. I., an ardent student of bee culture, and one who watched the bees for many hours at a time, discovered a plan by which he could see the bees at work and the larvae spinning their cocoons as well as if he had X-ray eyes.

It was his desire to see what the bees were doing in the cells; and one day when a small burr of comb was found built against the glass, and a bee seen at work in it the idea was conceived of fixing in an observation hive a small comb or several of them, so that a whole row of cells was parallel to the glass. It is not necessary to describe the many and crude attempts before success was achieved, but at last a stage was reached, where a row of combs was fixed between two panes of glass crosswise about four inches apart, and a small colony established therein.

There came a day when eggs were seen in cells next to the glass, and in due time they hatched and the larvae were fed and grew until they touched the glass, then the bees pulled them out. The shutters were tried but with not much success. Then "storm sash" in the form of an extra pane of glass on each side were ap-

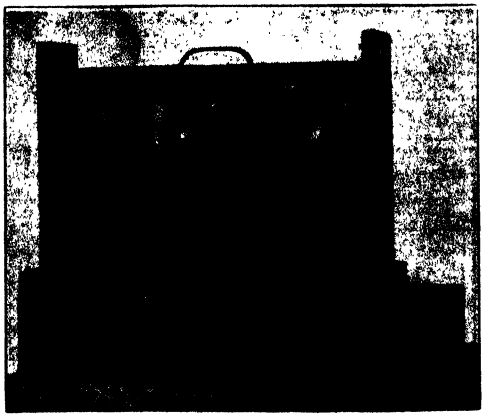


A close view of comb built against the glass of the Miller observation hive. This form of hive enables the observer to see the bees at work in the cells, the hatching of the egg, and the devlopment of the larvae.

plied and, the hive was a success. A quarter of an inch confined air space was left between the panes.

From then on the bees used the cells next to the glass as readily as the others. Almost every action was observable; the bees could be seen every way except face to face. Another hive was made and stocked and a piece of comb was put in which was less than half a comb, for it was only the cell walls from one surface of the comb. The glass wall of the hive was to—and did—form its new base. The bees used it as readily as the other combs, and the queen laid in it and bees were raised in it. The book of nature had been opened at a new page.

The distance between the inner panes has been varied from half an inch to three inches. The former is too close and the latter unnecessarily wide. An inch to an inch and a quarter is best, and then



Miller's observation hive with the combs built in crosswise.

no bee can completely escape observation.

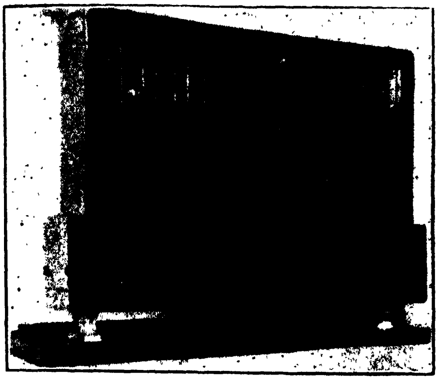
To stock this type of observation hive is a little troublesome. The two panes of one side of the hive are removed and the hive is laid on its side in a box prepared for the purpose, the "tunnel" of the hive connecting with an entrance in the side of the box. If this box arrangement is not used, trouble will be experienced by bees clustering on the outside of the ventilators. A sheet of new comb has previously been given to a colony; and as soon as it has larvae one to three days old it is ready for use. It is cut vertically into strips just a little narrower than the space between the inner panes. These strips are then laid in the hive, spacing them about an inch and a half from center to center. It is desirable that comb containing some honey be used also, and if there is not any honey in the upper part of the brood-comb, a strip or two of comb containing honey should be cut from some other sheet. If cells with the ends against the glass are also desired, a little more delicate work is necessary.

From a new dry comb a strip somewhat wider than needed is cut, then with a hot knife the cells are cut from the base. These baseless cells are very delicate and must be cut to the required dimensions with the hot knife. They are then lifted on a cool knife or piece of cardboard and slid into position in the hive. No gluing or waxing is needed, for the bees will do that perfectly.

The other pair of panes is next carefully slid into place. If any of the strips were cut too wide the glass will hit and move them and cause a lot of trouble, but otherwise the operation is easy. The entrance-guard is lifted, a queen put in and the guard replaced, and the cover put on the box. Onto a wide board in front of the entrance are now shaken the bees from two combs taken from any hive. The older bees will go home, the others will crawl into the hive. They go in better if the hive is dark; hence the putting of the cover on the box; but it may be opened from time to time to watch matters. If they are a little slow to enter they may be hurried by a gentle puff of smoke now and then, but on the whole it is better to let them take their time.

This operation is preferably done near the close of the day, and at a time when nectar is being secured, then robbing is not troublesome.

The hive is left in its horizontal position for a couple of days, the box being shaded from the direct rays of the sun. If it is found that not enough bees are in the hive to fill the spaces fairly between the strips of comb, more may be



Observation hive arranged with narrow frames made of glass. The combs are placed crosswise in the hive, thus enabling the observer to see within some of the cells.

shaken in front at any time. In about two days all of the combs will be seen to be attached to the upper one of the inner panes. By the time this is noted one may be certain that the combs are likewise attached to the lower one of the inner panes. The hive may now be taken from the box, set in an upright position, and taken away.

Maintenance and Operation

As soon as the hive is in its place, syrup should be given in the feeder and feeding continued for several days, for the little colony has virtually no field force, and will soon exhaust the honey in the combs. Also the feeding will stimulate wax production and enable the bees to complete the combs. During a heavy honey flow these little colonies will gain stores, but in a light flow their field force is too small and help may be needed in the shape of syrup or honey in the feeder.

By coloring the syrup (using a candy color) it is easy to see just where it is put first and more or less of it moved afterward. An ounce of deeply colored syrup is enough to use at a time for this experiment.

If feeding is necessary in cold weather, use a hot syrup, nearly filling the feeder

(a half-pint.) It will warm the hive and arouse the bees, and as soon as the syrup cools sufficiently they will take it. Use for this purpose a syrup made of two parts sugar and one of water. If the weather is very cold, close the hive and move it to a warm room, keeping it there until the bees have taken up all or most of the syrup. If, however, the combs were packed with stores before settled cold weather, and the room temperature kept between 35 degrees and 60 degrees F. as the extremes, the bees will not need feeding until spring.

This type of observation hive is good for about two years without renewing the comb, but by that time the comb becomes dark and opaque and the glass more or less coated with wax lumps, propolis, cocoons, etc. Therefore it has proved more satisfactory to restock the hive every year.

Bees winter nicely in these little hives provided the temperature of the room does not go to freezing nor stay below 40 degrees F. very long at a time. A room temperature up to 65 degrees or even 70 degrees does not cause trouble in the winter, provided the hive entrance is wide open. A few bees may venture to go out; but by the time they reach the outer end of the tunnel they meet the cold air and turn back. A window facing south is the best for winter; but any exposure will do for summer, though one not facing the prevailing winds is to be preferred.

All types of observation hives should have the ventilating space solely at the bottom of sides or ends, and with double glasses with a confined-air space between them. Extra space into which the bees may spread and yet not build comb is greatly to be desired, particularly in single-comb hives. This and ideal ventilating conditions are secured by having the floor wider than the hive and having such extension covered by wire cloth spaced half an inch above it.

ORANGE (*Citrus Aurantium*).—The orange is a native of southeastern Asia, whence its cultivation has extended since the tenth century throughout the warmer regions of both worlds. All the species are evergreen trees or shrubs. Most of them have fragrant white flowers.

The cultivation of the orange and other citrus fruits is confined in this country to southern California and in Florida chiefly to the southern half of the peninsula, although when given special care and protection during cold winters, they will flourish as far north as Jacksonville. In northwestern Florida, west of the Suwanee River, and northeastern Florida north of St. Augustine only a very small area of citrus fruits is under cultivation. In the central lake region, comprising the eight counties of Alachua, Marion, Putnam, St. John, Volusia, Orange, Lake, and Sumter, there are over a million and a half of trees. Along the west coast in Citrus, Hernando, Pasco, Hillsboro, Pinellas, and Manatee counties there are also numerous orange groves.

A large acreage of oranges, mostly of the Satsuma variety, has been planted along the coast of the Gulf of Mexico from Florida to Texas. The bloom does not yield much nectar. About 40 miles below New Orleans, La., in the Delta of the Mississippi River in Plaquemines and Jefferson counties, there are many miles of almost continuous orange groves.

Orange blossoms.

The trees remain in blossom for about four weeks if the weather is not too hot and dry. As a rule, the later the bloom appears, the shorter the time it lasts. Cool and frosty weather will prolong it unless the frost is so severe, as occured in Florida in 1911, that it injures the blossoms when it brings the flow speedily to a close. The average surplus in a good year is about 40 pounds.

An orange grove in full bloom, displaying innumerable white blossoms among the dark-green leaves and exhaling a sweet fragrance that can be perceived for a quarter of a mile in all directions, is beautiful beyond description. The bloom is as sensitive to weather conditions as is that of the mangrove. Either very hot and dry weather, or sudden changes to cold and wet weather, will lessen the flow.

Florida orange honey is light colored, clear, and without the thick opaque appearance sometimes observed in even clear amber palmetto honey. It has a body heavier than cabbage palmetto, but not as heavy as scrub palmetto honey. The flavor and aroma, which preserve the fragrance of the blossom, are delightful, and can not be duplicated in any other honey.

In Arizona, orange and grape fruit culture are important industries in the Salt River Valley in Maricopa County where there are 2500 acres. The orchards are confined to the slopes, which are free from orange-killing frosts. The oranges in this section ripen early, and the first shipments often reach the eastern markets in time for the Thanksgiving trade. The culture of orange and grapefruit will expand considerably in those parts of the Salt River Valley where winter temperatures permit and there is an average water supply.

The Orange in California

The orange was introduced into California by the early Catholic missionaries, but its cultivation on a commercial scale began about 45 years ago.

While oranges are grown to some extent in many counties in California there are two well-defined dense areas of production. The smaller area is in the foothills of the Sierra Nevada in the San Joaquin Valley.

The larger area of citrus fruits is located in the southern and western foothills of Los Angeles, Orange, San Bernardino, and Riverside counties. There is also considerable commercial production in Santa Barbara, Ventura, and San Diego counties. Northward in the Central Valley in Butte County many acres of orange trees are to be found. Citrus fruits can indeed be grown in favorable localities from San Diego County to Shasta County.

As with many other honey plants, the secretion of nectar varies in different localities and is greatly influenced by weather conditions. In the cool regions near the coast there is little nectar. Fog also often interferes with the flight of the bees so that there may be very few days which are ideal for field work. In the foothills it is occasionally very cold; and an apiary at an elevation of a few hundred feet has been snowed under for a few hours, while in the valley below the orange trees were also white—but with flowers, not snow. At Redlands the weather is very warm and there is little fog with the result that, four years out of five, orange bloom yields a fair crop, in proof of which may be cited the experience of a beekeeper who states that he has shipped one or more carloads of pure orange honey every year except 1904. Yet even here the weather is sometimes so cool that tons of nectar are lost because the bees are forced to remain in the hives. Even in fair weather the flowers have been known to yield only a scanty supply of nectar. But when the conditions are suitable there is probably no other plant in the United States which secretes nectar more copiously. At times the clothing of pickers and pruners is wet by the dripping nectar, and the horses and harness require washing at the close of a day's cultivation among the trees; while even the ground is dampened by the many falling drops.

The very heavy water-white honey is unsurpassed in flavor; but as it usually crystallizes in a few months many dealers prefer to buy sage honey. It is very easy to obtain orange honey pure, for sage does not blossom until the weather is warmer. At Pomona the land for miles is entirely occupied by groves, and it is difficult to obtain room for an apiary. Here, after the honey flow is over, the bees bring in nothing for the rest of the season except a dribble of dark honey from pepper and hoarhound. Taking it all in all, the orange is the most dependable source in southern California.

A large acreage in California is devoted to the cultivation of the lemon and grape fruit, but these trees do not yield nectar as freely as does the orange. The other citrus trees are not common.

In southern California the trees are in bloom during the last of March and throughout April, or about six weeks. The period of blooming varies greatly—

sometimes being much later than usual. It would be for the advantage of apiarists if the honey flow were later, for while it aids in building up the colonies, the latter are often not sufficiently strong to bring in all the nectar, or the cold compels them to remain inactive. With large colonies and clear warm weather the nectar comes in very rapidly.

OUT-APIARIES.—Within late years this term has been used to apply to a bee-yard remote or distant from the home yard by about two or three miles. It is a well-known fact that only a limited number of colonies, comparatively, can be supported in any one locality, different places being able to support widely different numbers of colonies.

Number of Colonies in an Apiary

The number of colonies of bees that can be profitably kept in one locality is limited by the amount of pasturage. Of late years quite a number of beekeepers have established one or more out-apiaries, for the sake of keeping more bees than the home pasturage would support. Just how many bees can be supported in a single locality has probably never been ascertained, and it is just as probable that it never will be. One field may support five times as many as another, and the same field may support five times as many this year as last. Most beekeepers, however, think it inadvisable to keep more than 75 to 100 colonies in one apiary, while a few think their locations so good that 200 or more can be profitably kept together. As many as 500, and in one case even 700, have been kept in one yard. These cases are very rare, however, as it is seldom that the bee pasturage is strong enough to support so many.

As a general rule, most localities will not support to the best advantage over 75 colonies to the yard. In a series of outyards owned by the authors it was found an advantage to have not more than 50, although there are some seasons when a larger number could be operated to advantage.

The number of hives per apiary will depend very much on the amount of available forage for the bees. A locality that has a large acreage of alsike, some red clover, white clover, and sweet clover will support twice as many colonies as one where there is only white clover.

In western territory where alfalfa, sweet clover, and white clover are grown, the number of colonies will depend on the number of acres grown as well as on the time when the alfalfa is cut. Some ranchmen cut their alfalfa earlier than others. Some grow alfalfa for seed. Where seed is raised, a much larger number of colonies can be handled to advantage.

It is almost impossible to give a definite number per apiary. One may have to experiment to determine how many he can keep. In an eastern locality if there have been early spring rains and there is a considerable amount of alsike, sweet, and white clover, and especially if there is some alfalfa, 75 colonies to the yard can be operated to advantage. If there is only white clover available probably not over 30 could be placed. In that case the farmers should be urged to put in alsike and sweet clover. If they can be induced to give them a trial on the basis of the beekeeper's furnishing the seed at half price, they will probably continue to use them year in and year out, with the result that the locality will be measurably improved. (See Alsike, under Clover and Sweet Clover). As a rule it is better to have too few colonies than too many to the yard; and it should always be borne in mind that strong, powerful colonies will gather relatively much more than the weak or medium. (See Building Up Colonies, Brood and Brood-rearing, Food-chamber, and Demaree Plan of Swarm-control.)

In these days of automobiles, by which one can cover three or four yards in the afternoon, it is not so necessary as it was in the olden days of the slower horse and wagon to have so large a number of colonies per yard. For that reason, if for no other, it is safer to err on the smaller number.

Some yards will show up much better than others year after year. In that case a larger number can be placed in such yards.

Distance Between Apiaries, and Location Thereof

A location for an out-apiary must, of course, be far enough distant from the home apiary not to interfere much; but just how far is best, it is not easy to decide. Perhaps, all things considered, a good distance is from three to five miles apart. As the area of flight is a circle, the ideal plan of locating out-apiaries so

as to occupy fully all adjoining territory is to put them in hexagonal form, in which case a circle of six will surround the home apiary.

Many reasons will make it desirable to vary. The roads may run in such directions as to make a difference; no good place may be found for any apiary at some of the points. It may be remarked that the area of flight is not always a circle. An apiary placed in a valley between two ranges of hills might have an oblong area, the bees perhaps flying twice as far along the line of the valley as in the other directions. When an apiary is on a hill overlooking a valley bees will fly farther than when on a level. Again, the honey sources may all be in one direction (See Flight of Bees, page 298.) If only one yard is to be planted, it is probably best to go in the direction of the best pasturage—a thing not always easy to determine. Sometimes one location proves to be better than another, year after year, although no apparent reason for it can be seen. It may even be worth while to vary a location a mile or more for the sake of having it where pleasant people live. But one can do much toward making the neighbors pleasant by being pleasant himself. As little trouble as possible should be made, and one should be still more careful than at home to avoid everything that may invite robbing, for robbing begets cross bees on the place.

Since the days of the automobile and the automobile truck it is feasible to locate bee-yards much further apart than was practicable under the old plan of horse and buggy or team. While it is true that bees often do not fly more than a mile, and sometimes not over half a mile, it is equally true that some seasons they will go five miles. As already stated, the general lay of the land, the condition of the roads, etc., will determine to a great extent the location of the outyard. As far as possible, apiaries should not be remote from macadam, gravel, or brick roads. They should also be in sight of some dwelling house. This is important. Thieves are less inclined to meddle with the bees when the apiary is in sight of some home.

It is important also to have the apiary located where there are suitable windbreaks. (See Apiary and Wintering.) This is especially important if the bees are wintered on their summer stands; for good wintering can not ordinarily be secured outdoors when the hives, no matter how well packed, are exposed to piercing winds.

Hauling Bees and Bee Supplies to Outyards

It is not necessary to buy an expensive truck. An ordinary light machine selling for less than $600, with a wagon-box on the back, will handle practically 95 per cent of the out-apiary work provided there are not more than four or five yards. For very heavy hauling a big truck can usually be hired at an expense of about 20 cents a mile, including driver; and this will be far cheaper than for the beekeeper to own the machine. Or a two-wheeled trailer can be hitched to the light machine and carry 750 pounds in addition to 500 or 750 pounds on the truck itself. The automobile without a

A four-wheeled trailer made of parts of old automobiles.

trailer can carry 750 pounds to the trip, and thus do practically all the work, even to hauling the bees home in the fall. However, it is now the policy on the part of out-apiary beekeepers to winter at outyards in one of the packing-cases. (See Wintering Outdoors.) The small machine can, therefore, do all the hauling provided the owner manages to take a light load at each trip, both going and coming.

If there is a series of eight or ten yards one can well afford to have a light machine to carry the men to and from the yards, and a trailer* capable of carrying 750 pounds more, although it is surprising to see how much work can be accomplished with a small machine. (See Moving Bees.) Most beekeepers are now using a light enclosed truck. It is much

*E. L. Hoffmann, Janesville, Minn., handled 1,000 colonies with one assistant, a Ford, and a trailer. He secured big crops of honey, and with his Ford he sold and delivered his crop in his locality. The Ford with trailer is used very commonly in California and other states.

more convenient for delivering honey and hauling supplies. Moreover, it can carry the family.

Rent for Out-apiaries

The agreements between a beekeeper and his landlord, for rent, are as varied as the cases that occur. Some pay a fixed sum, five to ten dollars per year; some pay ten cents per colony; others agree to pay a per cent of the crop; some make a bargain to pay so much for every swarm hived by some one of the landlord's family, and so on, while some can not get the landlord to agree to take any rent whatever. In this latter case it is only right to make sure that the landlord has a good supply of honey for his family to use during the coming year. In any case, be sure to do a little better than expected.

General Management of Out-apiaries

A man at each yard is too expensive, and it is, therefore, better to have one force operate all the yards, using an automobile, even if an occasional swarm does get away. This plan has the advantage that the owner of the bees can always be present with the men, directing the work, thereby securing efficiency and at the same time better service. The helpers usually work better when the boss is around; and the boss who does not supervise his own job will soon run himself out of business. One who is capable of operating a series of outyards is capable of directing his men, and usually he is a man who has gradually grown into the business, increasing it from year to year as knowledge and experience permit.

It is not essential that a helper should have experience. The beeman who uses his brains can take a comparatively raw man or boy and almost double his own capacity for work in a day. The author's yardman takes along with him one or two helpers. The helper with smoker opens up the hives in advance, so that all is ready when the boss makes his inspection. His practiced eye will see almost at a glance what treatment is required, and he will, therefore, direct his helper or helpers to bring him the necessary equipment to put the colony in proper condition. An experienced man who has his plans well worked out will be able to keep one man bringing him stuff. As the men acquire more experience the boss simply tells them what to do with a colony. In the meantime he studies the needs of the next colony.

At every outyard there should be a small collapsible building. (See Buildings.) This is to hold extra combs, supers, and equipment; and if the extracting is performed with a small hand machine it can be done in a building of this sort.

Central Extracting Plant

As given under Extracting, the author advises one large extracting-outfit at the home yard, where the work can be done inside of a bee-proof building. It is not advisable ordinarily to extract at outyards, on account of the danger of robbers, and because conditions usually are not favorable for putting up an extracting-outfit.

In the case of bee disease it is sometimes necessary to extract at the outyard, in order to avoid mixing the combs and the danger of carrying disease to the home yard. But even in that case, if one plans rightly he can arrange to take his combs off, load them on the machine, carry them home, extract, and return. There should be a drip-pan in the wagon-box to catch any drip from the supers after extracting. And it may be advisable to throw a large canvas over the load to keep any bees in the home yard from getting a taste of the honey. In any case the extractor should be thoroughly washed out with boiling water after extracting from diseased or suspected combs. Such work can not be done too carefully. (See Extracting, subhead Central Extracting Station.)

Wintering Out-apiary Bees

It was formerly the practice of some to haul the bees home from the outyard and put them in a large cellar. This was too expensive and except in the far north where the winters are severe, it has been abandoned. Others winter in double-walled hives or packing-cases. (See Hives, subhead Double-walled Hives, or Packing Cases under Wintering Outdoors.) If there is danger that the bees may be molested by thieves or boys, it is advisable to haul the bees home and winter them under the eye of the owner. Usually an outyard can be located in sight of some house. If the land is rented from the owner of the house he will be willing to keep a watch on the bees: but as a usual thing bees may be left out of doors year in and year out without disturbance.

If the bees at the outyard are furnished with food chamber (See Food Chamber)

in the fall and packed, they will not require much attention except to see that the entrances do not become clogged with dead bees, which may happen along late in the winter. Usually some one near the outyards can be hired to rake the dead bees out of the entrances, as it may not be practicable for the owner to make a visit when roads are bad. (See Entrance.)

Failing Locations

The inroads of civilization sometimes cut off the honey resources of a locality; at other times they augment them very considerably. There are a few locations in New York that formerly gave very little honey until the farmers in recent years introduced buckwheat to such an extent that these are now excellent honey locations; and the yield of this dark rich honey plays a considerable part in the net profits of the season. In California some sage locations that were formerly good were ruined by fire. In other sections of the state the planting of extensive orange groves has converted these places into excellent locations for apiaries.

A Caution About Entering Into the Outapiary Business

While there are many beekeepers who have brains and capacity enough to manage a series of out-apiaries, there are also more who should never think of going into the business. To be a keeper of several out-apiaries means great perseverance and a good deal of system, besides ability to manage not only the bees, but the help who are to take care of them. If one can not make 50 or 60 colonies pay in one location, he should not delude himself by establishing a series of out-apiaries.

OVERSTOCKING.—This means putting more colonies in a locality than can be supported profitably. Sometimes a local beekeeper makes the mistake of putting too many bees in a place; but it more often happens that another beekeeper observing that the locality is good, brings in one or more yards, thus crowding the territory that was already overstocked in the first place. This means a loss to both parties.

A given locality with only ten colonies to gather the nectar in it may show a large average per colony — perhaps 150 or 200 pounds. When the number is tripled or quadrupled, the average will be cut down a half. The locality should be carefully studied, and only that number of colonies used which on an average, one year with another, will give the largest results in honey, with a minimum of labor and capital. If 75 hives during an average season would furnish an average of 150 pounds to the hive, perhaps the number might be increased to 100 or even 150. If, on the other hand, the average is only 50 pounds of extracted honey, and there are only 50 colonies in the apiary, then, clearly, 50 would be all that could be kept with profit in that spot; and it could be questioned whether or not 35 might not be just as profitable, and at the same time save a little in the investment and some labor in gathering and harvesting the crop.

In some locations, notably Wyoming, Montana, North Dakota, California, Colorado, Cuba, and in some portions of New York, one can have as many as 300 or 400 colonies, and in some rare instances 500 colonies in one apiary. E. W. Alexander, of Delanson, N. Y., had some 700 colonies in one beeyard; but he had immense acreages of buckwheat and goldenrod. The celebrated Sespe apiary in southern California, owned by Mrs. J. F. McIntyre, once had in one yard 600 colonies of bees. The great mountains on either side, the fertile valley, and the great abundance of honey flora made such a number possible. (See Apiary; also Out-apiaries.) That same locality today would hardly support even 100 colonies in one spot because the sage is gone.

Overstocking and Priority Rights

A new phase of overstocking has been developed within recent years, bringing up a rather difficult and serious problem. In good localities such as, for example, the irrigated regions of Colorado, the keeping of bees is much more profitable, or at least once was, than in some of the less favored localities in the central and northern states of the Union. It has come to pass that, in recent years, certain beekeepers, learning of the wonderful yields in North Dakota, South Dakota, California, Nevada, Colorado, Idaho, Wyoming, Montana, and Arizona, in the irrigated alfalfa regions, have started apiaries within less than a mile of some other beekeeper having 100 or 200 colonies in that locality. When the new comer establishes another apiary of 100 colonies, the place becomes overstocked, with the result that beekeeper No. 1 has his aver-

age per colony cut down very materially. There is only a certain amount of nectar in the field to be gathered; and if all the colonies get a proportionate share, then beekeeper No. 2 practically robs beekeeper No. 1 of a large percentage of honey that he would have obtained had not other bees been brought into the locality to divide the spoils.

There is no law against such a procedure. The only protection that the original squatter has is the unwritten moral law that is observed among the better class of beekeepers, to the effect that no beekeeper should locate an apiary so close to another as to rob him of a certain amount of nectar in the field which is his by priority of location. In a good many localities, unfortunately, this unwritten moral law is only loosely observed. Locations that once afforded an average of 100 to 150 pounds per colony now afford only about 50 or 75 pounds.

For the other side, on this question of priority of rights, it may be said that the first-comer beekeeper has in no sense leased, bought, or borrowed, the land growing the plants from which the nectar is secreted; that any and every one has a right to the product from the flowers. Legally, the second comer has just as much right to the field as his neighbor.

No attempt will be made to draw moral distinctions which may be involved in this question any more than to state that, if a beekeeper has, by luck, careful observation, or at great expense, discovered a locality that yields large amounts of honey, he ought to be left in the peaceful enjoyment and free possession of his discovery, to the extent that no one else should locate an apiary nearer than a mile and a half from any of his apiaries; and right here it would appear that the principle of the golden rule ought to be used to settle all such problems. It is practically certain that beekeeper No. 2, who comes into an occupied field to divide the profits, would not regard with very much favor such action on the part of another if he were in the position of the one having prior rights.

In many localities there is a very strong sentiment on the part of local beekeepers established in good territory against newcomers' putting more bees into a place already overstocked. This sentiment is so pronounced and strong that the new man is often glad to sell out or move away of his own accord. Sometimes he is stubborn, and attempts to fight it out; but usually he is the loser in the end, because he does not know the locality as do the old-established beekeepers, and his yields per colony will be considerably less. While the policy is not here advocated, local beekeepers sometimes agree on the plan of freezing out, or, more exactly, starving out, the newcomer. The latter enters the territory with a yard of bees. Immediately the old-established beekeeper or beekeepers will place around that yard, within a quarter of a mile of it or less, a lot more bees—enough to overstock the place very greatly. The old residents, knowing the locality, build up their colonies, and are ready for the nectar when it does come in. As there is not enough to go around by considerable, the bees will not secure an average of ten pounds per colony. But the old resident beekeepers will secure more than the newcomer because they know the locality and how to meet the conditions. After Mr. Newcomer has tried it one season, and finds he can not make anything, he will move out. This freezing-out or starving-out game has been worked to a finish in a good many places in the West. As a rule the resident beekeepers in the locality will agree among themselves to divide up the territory and put no more bees to the yard than the locality will support. This policy prevails in many of the orange and sage districts of California and the alfalfa districts of the West. A good feeling exists, and in some places they co-operate among themselves to sell their honey, perhaps picking out one of their number to visit the big markets. Such a policy is much more sane than for every one to grab territory and compete against his neighbor, with the result that no one can make a fair living.

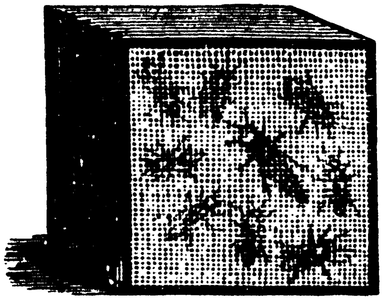
In one or two localities Mr. Newcomer has been met by a shotgun. He is told to get out or "take the consequences." As such a policy is, of course, indefensible, milder and gentler means should be employed.

As a rule the newcomer can find territory if he will make some inquiry before he attempts to locate his yard or yards. By making a personal visit and becoming acquainted with the beekeepers in any given locality, he can usually make satisfactory arrangements, and open territory

may be assigned if there is any. Sometimes none is available. In that case Mr. Newcomer should not attempt to crowd in, for he may find some one beekeeper who will get "sore" and resort to the shotgun argument.

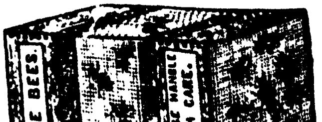
P

PACKAGE BEES.—It was A. I. Root who first conceived the possibility of shipping bees without combs. We find in the original edition of his A B C of Bee Culture, published in 1879, and also in Gleanings in Bee Culture in 1878, 1879,



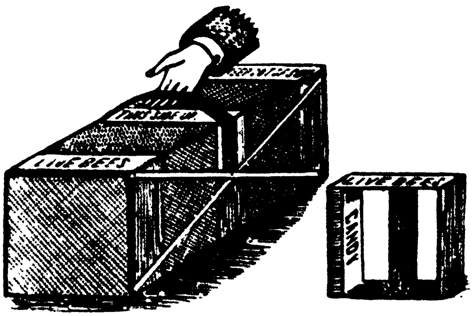
Cage designed and used by A. I. Root nearly 60 years ago for shipping ⅛-pound package of bees.

and 1881, an account of his experiments in shipping bees in wire-screen cages without combs, very similar to those now made. His original idea was not to eliminate the possibility of transmitting disease, but to reduce express charges. A heavy, bulky hive with a full equipment of combs necessarily made the express charges very high. A. I. Root early saw the possibilities of shipping a half-pound, pound, one, two, or three pounds of bees



A. I. Root's cage for shipping ½ pound of bees as made and used nearly 60 years ago.

in a light wire-screen cage. Two or three pounds of bees, enough to make up what would be equivalent to an ordinary colony wintered over, would weigh not over five or six pounds, cage and all, as against 45 or 50 pounds for a whole hive and colony. There would be no more bees in the full colony than would be in the little wire cage, and one would gather just as much honey as the other, provided it was released upon combs of honey in a hive already prepared. It was A. I. Root's idea to ship the hives, frames, and foundation in the flat at a very low freight rate, and ship the bees later in package form to be released in the hives after they were nailed and painted. At the time he worked out his idea he did not see that, in addition to saving enormous express charges, he was also going to prevent the transmission of American foul-

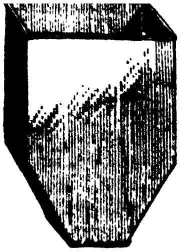


Cage for shipping one pound of bees. Illustrations on this page reproduced from June, 1881, issue of Gleanings in Bee Culture. Note the water and syrup bottle in the center of the drawing at the right.

brood from a locality having the disease to one that did not have it. At the time he worked out this idea foulbrood had not begun to be the menace that it is now.

At first Mr. Root met with many difficulties. His early experiments, while often successful, sometimes met with failure. He was not able to make the candy just right, and the bees starved to death on it. He therefore used metal

containers for syrup or water. With the water-bottle and the candy he finally succeeded in making good deliveries even over long distances. But there were so many failures in shipping bees on candy alone without combs that for a time the idea was abandoned. It was taken up later by the author, after having encountered



Tin funnel for filling packages, designed by A. I. Root, in 1881.

the obstacle of foulbrood being sent with shipments of bees on combs. Elaborate experiments in 1914, 1915, and 1916 were conducted by beekeepers all over the country. It developed that when the candy was "right," or syrup was used, the bees would go through in good order, especially in early spring. It was proved that syrup is the proper food. A few of the larger shippers finally discovered a method of making candy that would deliver seventy-five per cent of the bees in good condition in the early spring; but they were not able to make such shipments after hot weather came on.

Among the first if not the first to make successful shipments of package bees from the South to North was W. D. Achord, then of Fitzpatrick, Ala., near Montgomery. For a year or two he was the only one who could make a candy, not too hard nor too soft to carry bees through to destination. He was willing to show his neighbors the trick of making the candy, and the result was that in a few years thousands of packages of bees were sent from the vicinity of Montgomery alone to the northern beekeepers and orchard growers. The business, as soon as it was found that syrup was better and cheaper than the best candy, developed by leaps and bounds all over the South. Soon following Mr. Achord were M. C. Berry, J. M. Cutts, Jasper Knight, W. J. Forehand, and others.

W. D. Achord, pioneer shipper of package bees from the South.

Package Bees to Replace Winter Losses

Heavy winter losses in the more northern states began to bring to the front the

E. Harrell, Hayneville, Ala., (left) and Thomas Atchison, state inspector of apiaries, with two loads of bees ready for shipment.

possibilities of making good the loss by these package shipments. About 1918 and 1920 it was discovered that two or three pounds of young bees would equal the performance of a fair wintered-over colony in the production of honey. The following seasons several reports were made showing that two or three pounds of bees with a queen, placed on empty combs where the bees had died, would do as well as and sometimes even better than the wintered-over colonies. This was especially true when the packages were made up of young bees and supplied with syrup instead of soft candy.

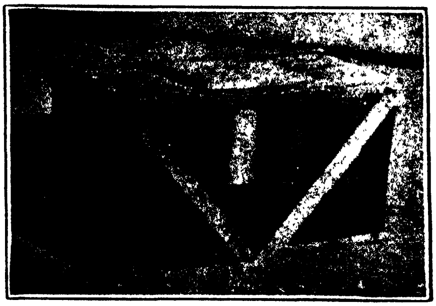
Package Bees Instead of Wintering

In 1926 and 1927, L. T. Floyd, Provincial Apiarist at Winnipeg, Manitoba, Canada, where the winters are very severe and the losses are heavy, suggested that beekeepers better let their bees die in the fall, sell their honey, and buy package bees from the southern states. The

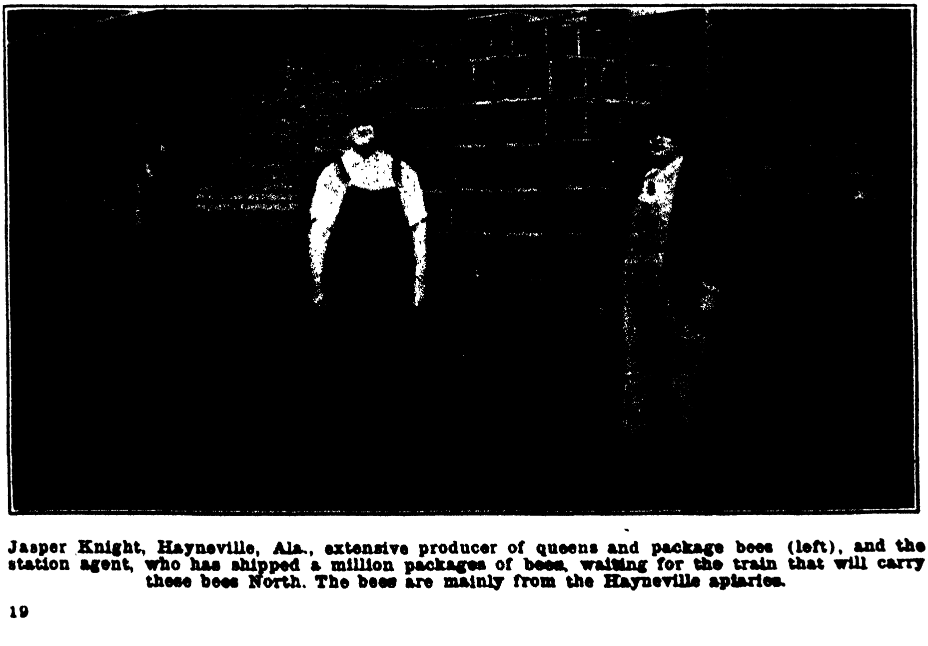
J. M. Cutts, Montgomery, Ala., veteran queen breeder and extensive shipper of package bees.

thing has worked out so successfully that there are now annually as many as 10,000 packages of bees being shipped from the southern states to Manitoba. These bees are liberated on combs of honey in early spring. The resulting colonies have demonstrated that they are able to secure some enormous crops of honey from alfalfa and sweet clover, which are being grown so extensively in the far North.

It is not known how far one in the



Open end cage with can of syrup that some prefer. See the Stover cage, page 578.

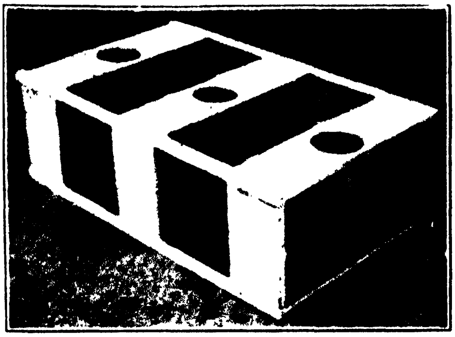


Jasper Knight, Hayneville, Ala., extensive producer of queens and package bees (left), and the station agent, who has shipped a million packages of bees, waiting for the train that will carry these bees North. The bees are mainly from the Hayneville apiaries.

northern states can probably go in allowing his bees to die or dwindle to practically nothing and then buy package

It is sometimes advisable to shake bees from extra strong colonies to unite with weak colonies.

bees to place upon those combs in the spring. At the prices of syrup and honey it is still cheaper in most localities to winter over bees, providing they are well packed, than to buy the bees from the South. Fifteen or twenty pounds of stores should carry the bees from late fall until the following April or May. In the more northern localities it might take 25 pounds. Calling the stores worth 10 cents a pound in the comb, the cost of wintering over the bees would not exceed $1.50 or $2.00. Package bees, on



The type of cage Mr. D. D. Stover prefers. Note that the slats on which the bees cluster are in a horizontal position in respect to their width and that the ends of the sage are solid.

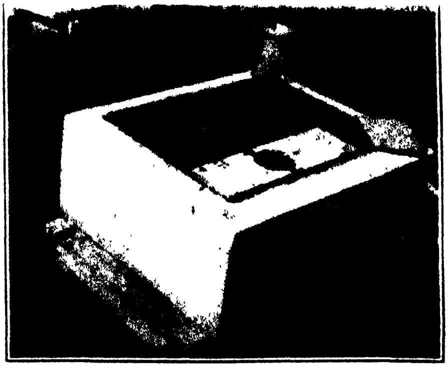
the other hand, would cost from $4.00 to $6.00 delivered, so that there is a saving in wintering the bees over for most localities. However, if one has to buy expensive double-walled hives and his labor cost is high, it is conceivable that the package bees might be as cheap or cheap-

Mr. and Mrs. A. I. Forehand, Fort Deposit, Ala., ready to drive to the apiary for a load of bees. Mr. Atchison at the left. Note that the cages are open end with four posts.

er than wintering the bees over. But even then, unless one is located in the far North where the winter temperatures play around zero and below, package bees should be used only to replace winter losses or to build up colonies that have wintered poorly and which could not, without a boost, do anything in the way of storing honey.

Package Bees for Strengthening Weak Colonies

In the olden days, before the package bee business was known, heavy winter losses meant that the equipment of combs, hives, and all were idle during the season. It took a whole year to build the bees up to their former strength, and then there was the chance of severe winter losses again. It is evident that the package business is really insurance against heavy losses. If one has lost 50 per cent of his colonies and the other 50 per cent are medium and weak colonies,



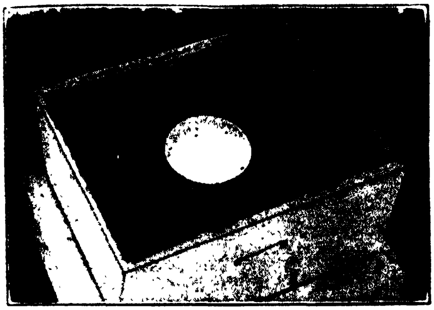
A queenless package added to a weak colony at the right time results in a strong colony for the harvest.

the whole bee-yard, at an expense of from three to six dollars a colony, can be put into active working condition again.

In localities where the honey flow is fairly reliable, a five-dollar investment in bees might mean a return of from fifty to two hundred pounds of honey. On the basis of a crop of fifty pounds, the package bees would have paid for themselves. On the basis of a hundred pounds there would be $5.00 to the good, putting honey at 10 cents a pound. While 10 cents is high for carload shipments, much of the honey is sold in a retail way around home, some of it bringing 20 and 25 cents a pound. It is, therefore, believed that a ten-cent average is fair for most conditions.

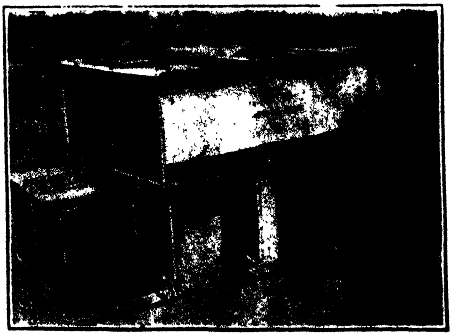
Type of Cage with Syrup Can That Has Given Excellent Results

Various styles of cages were devised for the shipment of bees without combs, but the one that has given excellent results is an oblong cage having a wooden top and bottom, supported by posts at the four corners, the sides and ends being surrounded with wire-cloth. The



Method of feeding package bees in an upper story by inverting a can of syrup.

wooden framework inside should be well braced with a few slats or strips of wood to help sustain the cluster and the feeder of syrup. The top of the cage should have a hole about four inches in diameter through which can be let down a syrup can containing just ordinary sugar syrup, made by mixing about equal parts of water and sugar. This syrup can has one or two holes in the cover the size of a very small wire nail, or 1-32 of an inch in actual measurement. One hole is liable to be clogged and, besides, might not feed the syrup fast enough for a two or three pound cluster of bees. By having two holes this danger is eliminated. If the



Package bees, crated for shipment. The cleats hold the packages apart to provide ventilation.

weather is warm and the cluster is large, three holes may be used; but, as a rule, two give better results than three and are always better than one. To prevent crystallization and clogging the holes, the sugar should be dissolved and thoroughly stirred. Mr. Floyd recommends that the syrup be run through cheese-cloth to remove any crystals.

While the queen may accompany her own bees and be allowed to run loose in the cage, the usual method is to cage the queen separately in an ordinary mailing cage. This makes it possible to take a strange queen. A shipper in the South can shake two pounds of bees into each of a hundred different cages. To place the queen-cage in with the cluster of bees, jar the cage downward so that the bees are deposited in the bottom of the cage, quickly insert the cage, and put back the syrup can. The cage should be held near the top with a piece of wire. Mr. Floyd suggests that the queen-cage have no candy.

On arrival at destination it is easy for the customer to see whether the queen is alive. If she is dead, he should immediately report the fact so that a new queen may be sent to replace her.

Installing Package Bees

Full directions for installing package bees are given under the head, Beginning with Bees. See page 81.

Importance of Young Bees

The northern beekeeper, when he orders his bees, should specify young bees and not old ones. Old bees are too apt to die in shipment. Even if they arrive safely they will die off rapidly after they are released in the hive. Stipulation should be made that bees should be delivered on a certain date. The earlier in the season the better, because bees travel better in cold weather or cool weather than in hot. The earlier the shipment the fewer the bees that will be required.

Unless the shipper from the South is well known, do not send money to a new man, but deposit it in the local bank with instructions to pay after the shipment has been received and its condition noted.

PALMETTO.—In Florida the cabbage, scrub, and saw palmettos are valuable sources of nectar. The cabbage palmetto (*Sabal Palmetto*), so called from the cabbage-like terminal bud, which is boiled and eaten like a cabbage, is found in the sandy coast regions from North Carolina to Florida, and also occurs in Cuba and the Bahamas. It grows from 20 to 50 feet tall, and is abundant along the east and west coasts, on the banks of rivers, and in hammocks throughout southern Florida.

In the extreme southern part of Florida the cabbage palmetto begins to bloom

A close-up of saw palmetto, so named because of serrated edges on the blade stalks that hold the leaves.

Saw palmetto pine land in Florida. Where the land is productive the shrubs will be large or head high as here shown, and the land will be good for growing almost any crop. This scene is typical in Florida.

about the first of July, but in the northern portion of the state not until August. The flowers are very sensitive to the weather; too much dampness blights, and a hot dry atmosphere blasts the bloom.

The honey is nearly white, or light amber-colored, and has a characteristic aroma, which does not resemble at all

Cabbage palmetto.

that of scrub palmetto. It is very thin, and in warm weather runs almost like water, and even in cold weather it never thickens. The flavor is extremely mild, but it is inferior to that of saw palmetto. Gas bubbles may frequently be seen under the cappings of the sealed cells, and during extracting the honey foams considerably, as though it were fermenting, but after it has stood for a few days the bubbles wholly disappear. But honey from unsealed cells will ferment enough to deprive it of its flavor. As it is a mild honey it blends well with other honeys.

The Scrub Palmetto

Two low shrubs with creeping or horizontal stems, called scrub palmetto (*Sabal megacarpa*) and saw palmetto (*Serenoa serrulata*) are the most widely distributed honey plants in Florida. Beekeepers frequently fail to distinguish between them, and regard them as a single species. The leafstalks of the scrub palmetto are sharp-edged, but not toothed, while the leafstalks of the saw palmetto are armed with numerous sharp spiny teeth. The true palmetto (*Sabal*) may readily be distinguished by the threadlike fibres on the margins of the leaves. In the scrub palmetto the three cells of the ovary are wholly united, but in the saw palmetto they are free at the base.

The scrub palmetto (*Sabal megacarpa*) is a low shrub with long, crooked, creeping stems, which are partly subterranean. It grows well over the southern two-thirds of the peninsula of Florida, becoming rarer and smaller toward the northern boundary of the state. It reaches the largest size south of a line extending from

Tampa to the east coast. On the west coast for miles north and south of Tampa it forms an unbroken sea of green. The honey is lemon yellow, thick and heavy, with an aromatic flavor and fragrance. It is considered one of the finest honeys in Florida, but possibly is surpassed by white tupelo or orange honey. It granulates early but not as quickly as orange honey.

Saw Palmetto

Saw palmetto (*Serenoa serrulata*) closely resembles scrub palmetto in flower and fruit, and also gives a large honey flow. The honey is similar to that of scrub palmetto, with which it is usually mixed, as both species bloom at the same time. As has been pointed out, the saw palmetto has a much wider distribution, extending far beyond the boundaries of Florida. No doubt the saw palmetto and scrub palmetto are often confused. (See "Honey Plants of America.")

PARTHENOGENESIS.—In the great majority of cases the sex cells disintegrate unless they unite with the products of the opposite sex of the same species; but in some cases of the animal kingdom cells are given off from the ovary, which, without fertilization, are able to undergo development. That these cells are true eggs is evident from their origin, appearance, behavior, and fate, while the only difference between these eggs and eggs requiring fertilization is that the former are able to divide and grow without receiving the stimulus given by the male sex cell. To this phenomenon the name "parthenogenesis" is applied.

The word parthenogenesis (virgin development) was first used in this sense by Professor v. Siebold in his classic paper, "Parthenogenesis in Lepidoptera and Bees," in 1856.

However, earlier writers described the phenomenon under various other names.

In 1745 Charles Bonnet described the parthenogenetic development of plant lice; and Prof. Oscar Hertwig, the great German embryologist, designated this work as marking one of the milestones in the history of the science of development.

Just one hundred years later the Rev. Johannes Dzierzon, of Carlsmarkt, Germany, put forth the theory that the drone or male bee is produced from an egg which is not fertilized. This work, published in the "Eichstadt Bienenzeitung," may well be looked on as the starting point of the theory of parthenogenesis, since it began a very important discussion, and marked the origin of a host of works along similar lines.

The Dzierzon theory has been combated by many different scientists, more recently by Dickel, a German beekeeper with scientific aspirations. While the Dzierzon theory has been somewhat modified by recent work, it remains the prevalent view today, and Dickel generally receives the condemnation so richly deserved. (See Dzierzon Theory for a further discussion of the subject, page 237.)

Parthenogenesis occurs in many other orders of both plants and animals, and a comparison of the various results is most interesting. Merely to cite some cases for comparison: In the bee, only males are produced parthenogenetically; in certain lepidoptera, only females are so produced; while in plant lice and certain small crustacea both males and females are produced from unfertilized eggs. Ants were formerly supposed to have a parthenogenetic development identical with that seen in the honeybee; but more recent work makes this doubtful as a general statement. The silkworm is occasionally parthenogenetic.

PARTRIDGE PEA (*Cassia Chamaechrista*).—Also called sensitive pea. Partridge pea is a herbaceous, much-branched, spreading annual with showy yellow flowers which often have the petals purple-spotted at base. It extends from Maine to Florida and westward to Indiana and Texas, but it is valuable as a honey plant chiefly in Florida and Georgia. In the north-central part of Florida there are thousands of acres in bloom during July and August, and for miles the ground is covered with a yellow carpet of flowers. It is also common in Georgia; in many dry sandy sections of the South; indeed, it is the main dependence of the beekeeper, making beekeeping possible in very unfavorable localities.

The blooming period is long, beginning the last of June and closing late in September. The flowers are wholly nectarless, and are pollinated by bumblebees, which visit them for pollen. But nectar is secreted profusely by extra-floral glands located on the upper side, near the

base of the leaf-stalks (petioles). Unless the summer rains are too heavy and continuous, nectar is yielded every season for more than 100 days. Much rain washes the nectar from the glands before the bees can gather it. From one to three supers of honey are stored from partridge pea, and 100 pounds per colony has been obtained.

The honey is medium-light amber, exceptionally thin, with a poor flavor. At Fort White, Fla., the surplus comes from partridge pea and chinquapin, which yields a bitter honey. Inferior as is the flavor of this honey, its fine appearance has caused it to sell at a high price. The extracted honey is bought by bakers, and the large quantity obtained partly atones for the quality. See "Honey Plants of North America."

PASTURAGE.—See Artificial Pasturage.

PEDDLING HONEY.—See Honey-peddling, Marketing Honey, and Extracted Honey.

PENNYROYAL (*Satureja rigida*).—See "Honey Plants of North America."

PEPPERBUSH (*Clethra alnifolia*).—See "Honey Plants of North America."

PEPPER TREE. (*Schinus molle*).—See "Honey Plants of North America."

PERFORATED ZINC.—See Drones.

PHACELIA (*Phacelia tanacetifolia*).—See "Honey Plants of North America."

PICKLED BROOD.—See Foulbrood, subhead, "Sacbrood."

PLAYFLIGHTS OF BEES.—See Behavior.

POISONED BROOD.—See Fruit Blossoms and Foulbrood.

POISONOUS HONEY.—The earliest account on record of honey causing sickness is given by Xenophon in the fourth book of the Anabasis. It occurred 40 B. C., during the memorable retreat of the Ten Thousand, in the mountainous country of the Colchians, in the province now called Trebizond bordering on the Black Sea. A literal translation of Xenophon's description is as follows: "The number of beehives was extraordinary, and all of the soldiers who ate of the combs lost their senses, vomited, and were affected with purging, and none of them were able to stand upright. Those who had eaten little were like men intoxicated; those who had eaten much were like madmen, and some like persons at the point of death. They lay upon the ground in consequence, in great numbers, as if there had been a defeat; and there was general dejection. The next day no one of them was found dead; and they recovered their senses about the same hour that they lost them on the preceding day; and on the third and fourth day they got up as if after having taken physic." The passage is given entire, as it has probably done more to establish a general belief that certain kinds of honey are poisonous than any other account ever written. The ancients believed that this honey was gathered from a species of *Rhododendrum*, probably *R. pontica*.

It is noteworthy that the honey was obtained from beehives, not from trees or hollows in the rocks.

Mountain Laurel Honey Poisonous

Poisonous honey in the United States was reported first by Barton, an early American botanist, in 1794. Since then poisonous honey has been repeatedly reported in the mountains of New Jersey, Virginia, and North Carolina. The honey, it is believed, is gathered from the mountain laurel (*Kalmia latifolia*) and the Rhododendrons. Mountain laurel is often called poison ivy in Tennessee and Alabama; poison laurel in Alabama and ivy in Virginia, North Carolina, South Carolina, Mississippi, and Maryland.

In 1921 a beekeeper living at Morganton, North Carolina, described conditions in that locality as follows: "There are districts in western North Carolina in which the so-called 'poison honey' is produced. About one-third of this county (Burke) can not be used for this reason. I have known beekeepers deliberately to throw hundreds of pounds of honey into the streams. As to the effects, I have seen and have also personally experienced the acute sickness which this honey produces. Within a few minutes after it is eaten a staggering, deathly nauseous sensation is experienced which lasts several hours. While I have seen whole families rolling in their dooryards I have never known of any fatal results. But the poisonous honey is eaten by bees year after year without injury. It is believed that the

poisonous honey has become more abundant in recent years because of the spreading of ivy over areas which have been cleared of forest. Most officials seem to doubt the existence of this honey."

For several seasons the author has had letters from beekeepers in North Carolina inquiring about a bitter honey coming from mountain laurel and asking whether it was poisonous to man or bees. The matter was finally referred to C. L. Sams, Extension Apiarist for the state of North Carolina. He writes:

Honey from kalmia is slightly bitter and is the so-called poisonous honey. At different times we have sent samples of this honey to Washington to ascertain the amount and kind of poison it contained. On one occasion we sent about fifteen pounds. All of the samples were taken from supers and honey which it was claimed had caused illness and suffering on the part of those who ate it. In spite of all this, every report from Washington was that no poison had been found in the honey. Having faith in the reports from Washington and not being willing to admit that any honey was poisonous, I ate a quantity of it at the home of H. S. Beck, Table Rock, N. C. It caused all the illness claimed for it, and I had to spend the entire afternoon in bed at a hotel in Morganton. The symptoms and illness were the same with me as had been claimed by parties living in communities where the honey is sometimes produced, but not every season. The first symptoms are a tingling of the fingers and toes, as if circulation had been stopped by tying a cord around the arms and legs. Very soon it becomes difficult to stand on the feet. This is usually followed by a severe headache, which lasts for one or two hours. Some of the farmer beekeepers in localities where there is abundance of mountain laurel (kalmia latifolia) test the first honey harvested after the blooming of this plant by feeding some of it to a dog. If the dog can walk in thirty or forty minutes after eating a piece of the comb honey about three inches square, the beekeeper will let his children help themselves. If the dog gets so he can't walk and acts as if he was suffering great pain, they dispose of the honey in some way other than using it as food.

In view of all this, I wonder if the honey from mountain laurel could contain some kind of narcotic which possibly reduces blood pressure, and for which the chemists were not looking.

It is possible that there is in this honey a poison that the chemist does not know as yet and which he can not now detect. The experience of Mr. Sams should be a warning.

Yellow Jessamine Honey Poisonous

In Georgia and Florida the yellow jessamine (*Gelsemium sempervirens*) is very abundant and bees visit the yellow blossoms from February to March. But it is doubtful if a surplus of jessamine honey is ever obtained. It is used chiefly for spring stimulation. According to one published statement the uncapped honey is poisonous and has even produced death, but the capped honey is perfectly wholesome. According to E. G. Baldwin, no injurious effect has ever been observed either from the nectar or the honey in the hives.

Yellow jessamine.

In addition to the laurels, rhododendrons, and yellow jessamine, poisonous honey is supposed to be yielded by species of *Andromeda*, *Leucothoe*, and *Pieris*. It will be noticed that all these plants belong to the heath family, or *Ericaceae*. One writer, indeed, refers to this entire family as a source of poisonous honeys; but this is clearly false, since the honeys gathered from sourwood and the heathers are excellent. The flowers and flower-clusters of *Pieris*, *Andromeda*, and *Leucothoe* are very similar to those of sourwood, and they may well yield an equally harmless nectar.

The Soapberry Tree

Thousands of bees are said to be killed by the nectar of the soapberry tree (*Sapindus marginatus*), a small tree found in the South. It belongs to the same genus as the maples, and the nectar is undoubtedly equally harmless. It is in the highest degree improbable that any plant produces

nectar which is poisonous to the insect pollinators. Nectar is an allurement, the role of which is to induce the visits of insects and to secure cross-pollination, and the production of poisonous nectar would tend toward self-destruction. It is impossible to imagine how such a condition could arise. But flowers often have poisonous petals, the purpose of which, in the opinion of Darwin, is to prevent leaf-eating insects from feeding upon them.

Honey from Poison Oak

The poisonous species of *Rhus*, as poison oak, and poisonwood of Florida, yield a large amount of honey. Very likely ill

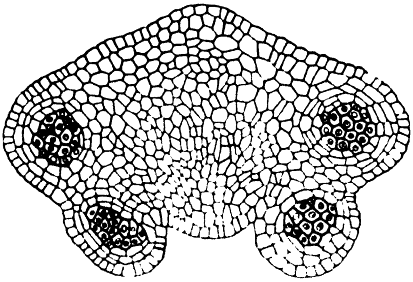


Fig. 1.—Section of young anther of lily showing the four sporangia from which pollen grains are developed. (After Coulter.)

effects would follow the eating of this honey before it is capped. But thoroughly ripened it is said to be harmless. It is well to remember in this connection that thoroughwort and cascara sagrada yield medicinal honeys and rabbitbrush a nauseous honey.

Further investigation is desirable, and meanwhile the so-called poisonous honeys should be used with great caution.

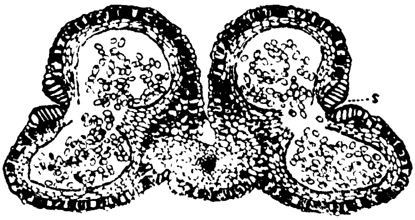


Fig. 2.—Section of older anther of lily showing sporangial cavities fused to form two pollen sacs which are filled with pollen grains. Dehiscence occurs at point marked S. (After Coulter.)

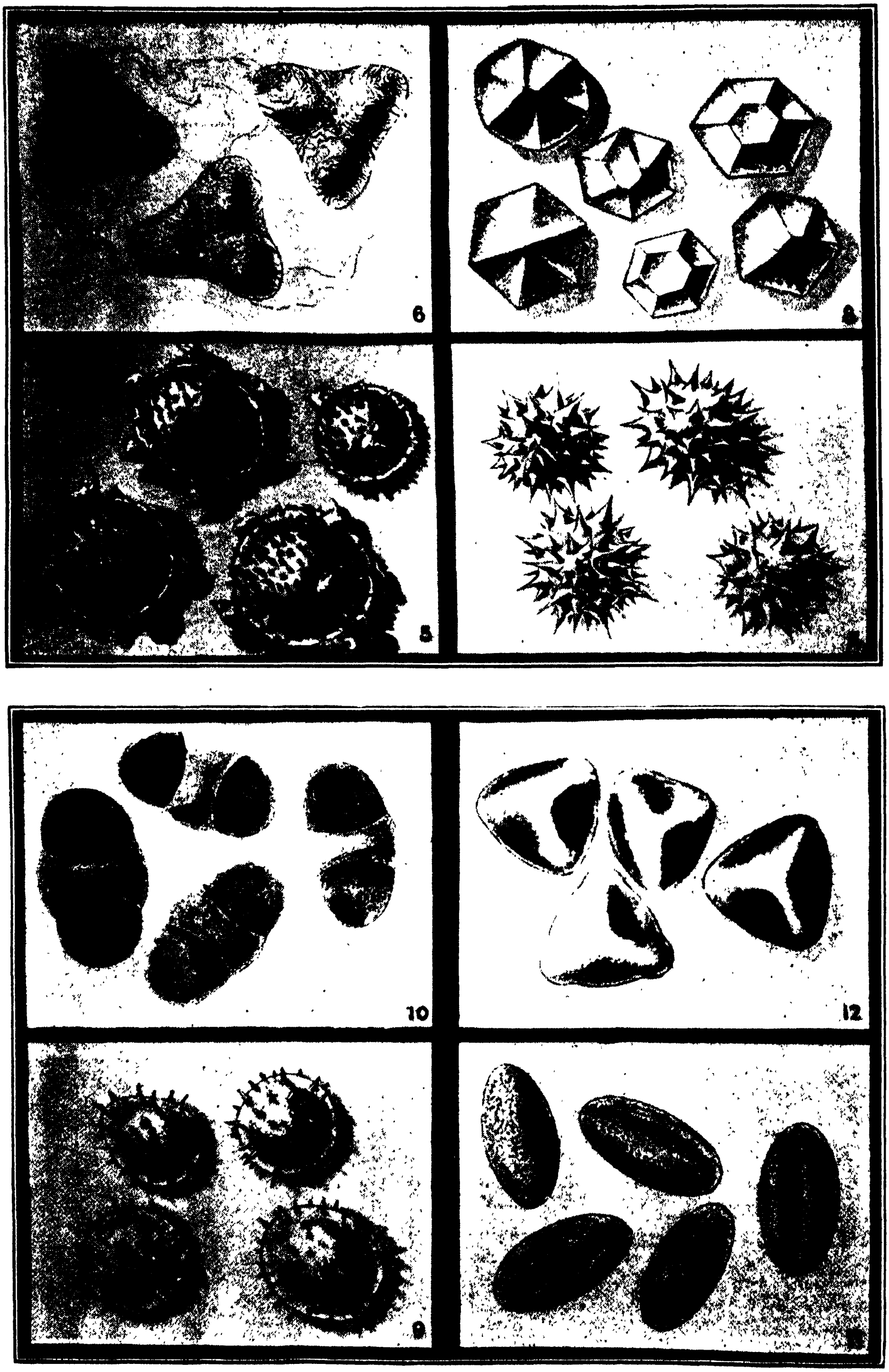
POLLEN.—The anthers of flowers are composed of four sacs, which contain numerous small dustlike grains called pollen or microspores. Pollen is a highly nutritious food which is eagerly eaten by many insects, and is gathered in large quantities by bees as food for their brood. A pollen grain is protected by an inner and an outer coat (in a few species there is but one coat), and is filled with

Pollen masses on the hind legs of honeybees.

a semiliquid in which float many minute granules. Its contents form a complete food, consisting of proteids, substances rich in nitrogen, sulphur, and phosphorus; and carbohydrates, or starch, oil, and sugar. Pollen thus offers a rich supply of easily obtained nourishment to all insects, especially to those not predaceous.

Pollen grains vary in size from 1/100 of an inch in iris to 1/3000 of an inch in some saxifrages. The number of pollen grains is also very variable, but is usually large. Each anther of the peony has been estimated to produce 21,000 grains; and if there are 174 stamens to a flower there

Loaves of bee-bread on the hind legs.



Types of pollen grains: (5) Vegetable marrow; (6) Rhododendron; (7) Marguerite; (8) Dandelion; (9) Mallow; (10) Scotch pine; (11) Lily; (12) Nasturtium. (After Bastian.)

Bees with masses of pollen on their legs.

would be 3,654,000 grains. In wistaria there are said to be 7000 grains to each ovule. The excess of pollen is thus so large as to permit of much waste. In shape the grains may be globular, ellipsoidal, polyhedral, or of the form of a dumb-bell in the borage family; or in some Polygalaceae they have the shape of "a wickerwork basket." The outer coat may be banded, ribbed, or checkered, and beset with sharp teeth, points, spines, prickles, or knobs; variation in the sculpturing is, indeed, almost endless. The air in the numerous little pits and hollows on the surface of the grains protects them from contact with water. The projections enable them to adhere to insects. While yellow is the prevalent color, red, blue, brown, and green hues also occur.

The Behavior of Bees in Collecting Pollen

The behavior of bees in collecting pollen is of great interest to both beekeepers and fruit-growers. Bees are the only insects which feed their brood on pollen, to obtain which in sufficient quantities they are compelled to visit a great variety of flowers, and incidentally are thus most valuable agents in pollination. The small primitive bees of the genus *Prosopis* have nearly smooth bodies, and the pollen-brushes on the hind legs are so feebly developed that they are little better adapted for carrying pollen than the wasps. The common ground bees of the genera *Halictus* and *Andrena* show a much greater advance. The body is hairy, and the hind legs are entirely covered with collecting hairs, which become filled with loose, dry pollen grains. A further step in the development of the pollen-collecting apparatus of the hind legs was the acquisition of the habit of moistening the pollen with honey. Among the solitary bees, *Macropis* and the *Panurgidae* carry in this way large balls of damp pollen moistened with freshly gathered nectar. Finally among the bumblebees and honeybees there occur on the hind legs structures called corbiculae or pollen-baskets, in which the damp pollen is packed, while the tarsal brushes are highly specialized. (See cuts page 589 and 591.)

In honeybees the tibial spurs on the hind legs, used by the wasps and solitary bees in digging holes in the ground, have been lost because no longer useful.

In another species of bees, the Megachilidae, or leaf-cutting bees, the pollen-collecting hairs form a stiff brush on the under side of the abdomen. These hairs slant backward and vary in length and color in the different species. As the bees crawl over level-topped flowers, like the sunflower and other species of Compositae, which have a large amount of free pollen on the surface, the abdominal brush becomes filled with dry pollen. The leaf-cutting bees are also very common visitors to leguminous flowers, as the vetches and clovers, which have an apparatus for placing pollen on the under

side of the bodies of insects. This large family of bees has become adapted to collecting pollen chiefly from those two groups of flowers. None of the species moisten the pollen with honey.

How the Honeybee Carries Its Pollen

The behavior of the honeybee in collecting pollen has been carefully investigated and described by Castell. ("Behavior of the Honeybee in Collecting Pollen," D. B. Casteel, Bur. Ent., Bull. 121.) Honeybees collect pollen from flowers by the aid of the mouth parts, the three pairs of legs, and the dense coat of long plumose hairs. The feather-like structure of the hairs enables them better to retain the pollen which falls upon them. The mouth parts are especially serviceable in the case of small flowers, or of those which produce little pollen. The mandibles are actively used in biting and scraping the anthers and freeing the pollen, which is brushed up by the *maxillae* and slender tongue. All the pollen gathered by the mouth parts is very thoroughly moistened with nectar or honey which comes from the mouth. It is, indeed, so wet that in its transfer to the pollen-baskets the hair on the breast and the brushes of the legs become so damp that it easily moistens the dry pollen swept from the bee's body.

The leg of a bee is composed of nine segments: The coxa, by which it is attached to the body; the trochanter, femur or thigh, tibia, or shin, and the five tarsi. The first tarsal segment or metatarsus, is as long as the four tarsal segments together. The segment of the forelegs is called the *palma* (palm), and of the middle and hind legs the *planta* (sole). The inner side of the metatarsal segments of all three pairs of legs bears a dense brush of unbranched hairs, which on the *planta* of the hind legs has become modified into a regular series of tranverse combs. The palmar brushes of the fore-legs take away the mass of wet pollen from the mouth parts, and collect the dry pollen from the pubescence on the head.

The metatarsal brushes of the middle legs receive the pollen from the first pair of legs and transfer it to the plantar brushes of the hind legs. This transfer is effected by drawing each of the middle legs between the plantae of the hind legs. In this way the pollen on each middle leg is scraped off on the pollen combs of each opposite hind leg. The middle legs also brush off the pollen entangled in the hair on the thorax, which is moistened by coming in contact with the wet pollen from the mouth parts. The middle legs are further used to pat down and compact the growing pollen mass in pollen-baskets.

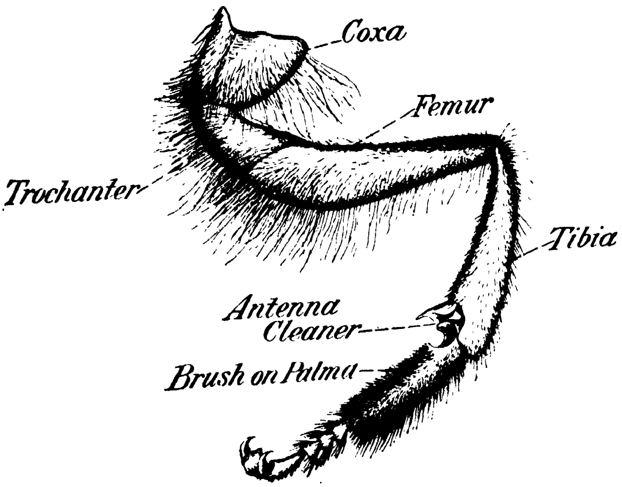


Fig. 1.—Left fore leg of the worker bee.—Bulletin No. 121, Bureau of Entomology.

The hind legs are very highly specialized for carrying the pollen masses. The tibia is dilated at its lower extremity and the metatarsal segments (*plantae*) are much thinner and wider than the corresponding segments of the fore and middle legs. The pollen-baskets or corbicula

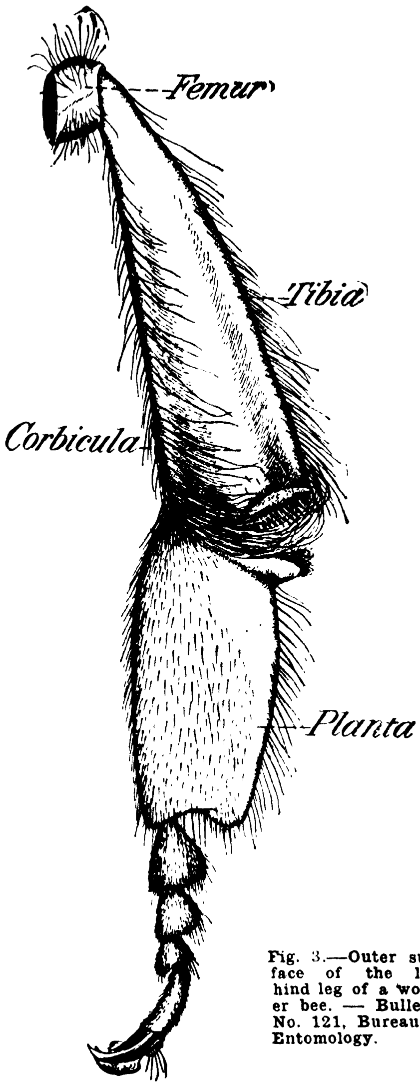


Fig. 3.—Outer surface of the left hind leg of a worker bee. — Bulletin No. 121, Bureau of Entomology.

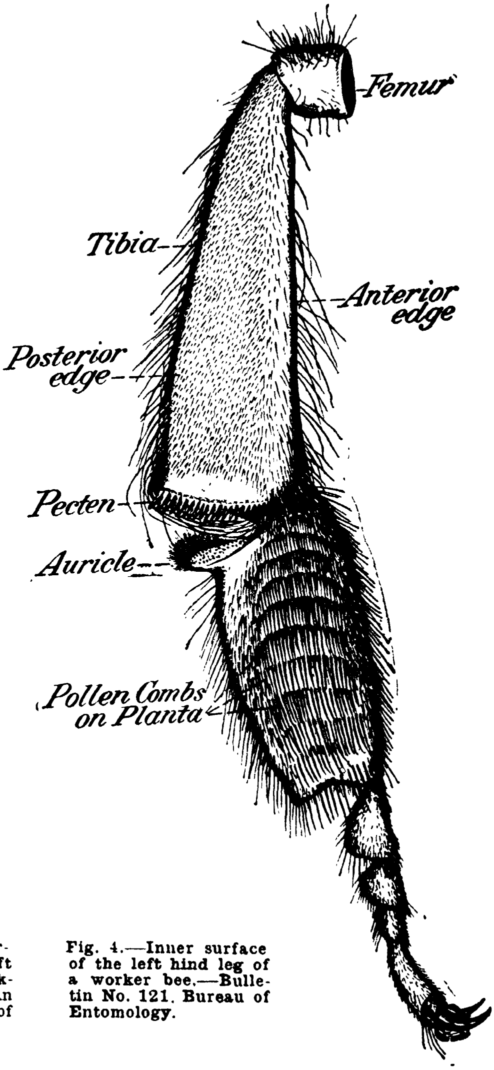


Fig. 4.—Inner surface of the left hind leg of a worker bee.—Bulletin No. 121. Bureau of Entomology.

is a longitudinal groove on the outer side of the tibia. It is broadest at the lower end and is nearly surrounded by a salient rim. On the front edge of the tibia there is a fringe of hairs overreaching the pollen-basket, and on the hind edge a row of hairs slanting backward. The floor of the basket is nearly smooth except for a few small spines near the entrance. The moistened pollen is held in position largely by its adhesiveness. The lower end of the tibia, except the articulation, is truncated, slightly concave, and fringed along its inner margin with 15 to 21 stiff spines inclined backward, called the pecten. Immediately below the flattened end of the tibia on the upper edge of the *planta* is the auricle. The ear-shaped structure is concave and covered with short spines. Its inner edge, when the leg is straightened, slips along the spines of the pecten, while its outer edge, which is fringed with hairs, projects into the entrance of the pollen-basket. The ends of the tibia and the auricle have the appearance of a pair of jaws or pincers, and in the older works

on bee culture are erroneously described as being used for taking scales of wax from the wax-pockets. The inner side of the planta, or metatarsus, is covered with about eleven transverse rows of stiff spines which serve as pollen combs. The spines of the lowest combs are the largest and are used for picking up wax scales. This highly specialized apparatus receives the pollen and loads it into the pollen-baskets. (See illustrations on pages 588, 589, 591, and below.)

Most of the pollen on the plantar combs of the hind legs is received from the middle legs as has been described, but a portion of it is swept from the abdomen. During the act of loading the pollen into the corbiculae, which has been described in much detail by Casteel, the hind legs hang downward beneath the abdomen, and the plantar combs are in contact for most of their length. If pollen is to be loaded into the left pollen-basket the right planta is drawn upward, scraping against the pecten of the left leg. A small portion of the pollen will be left on the spines and the end of the tibia. The left leg is then flexed, pushing the auricle against the flat end of the tibia, squeezing out a thin layer of pollen. The spines of the pecten prevent this layer of pollen from escaping on the inner side, but on the outer side there is a way open to the pollen-basket. In a similar way pollen is transferred from the plantar combs of the left leg to the right pollen-basket. The movements alternate very rapidly, the legs rising and falling with a pump-like motion. As the amount of pollen loaded at each stroke is very small a great many strokes are required.

The pollen at first lies at the extreme lower end of the pollen-basket, but as successive layers are added it is gradually pushed upward. If pollen from different species of flowers and of different colors, which occasionally happens, is collected, the mass will have a stratified appearance. The shape of the pollen mass is largely determined by the hairs which fringe the sides of the basket. The hairs on the front edge, which curve inward, prevent it from projecting far forward; while the hairs on the posterior edge, inclined outward, permit it to extend backward far outside of the tibia. Casteel found it possible to manipulate the legs of a recently killed bee with a pair of forceps, and artificially load the pollen-baskets with thin layers of pollen as has been described. It was formerly believed that in loading the pollen-baskets the hind legs were crossed, and the plantar combs scraped over the edges of the baskets and the fringe of hair. On trial it

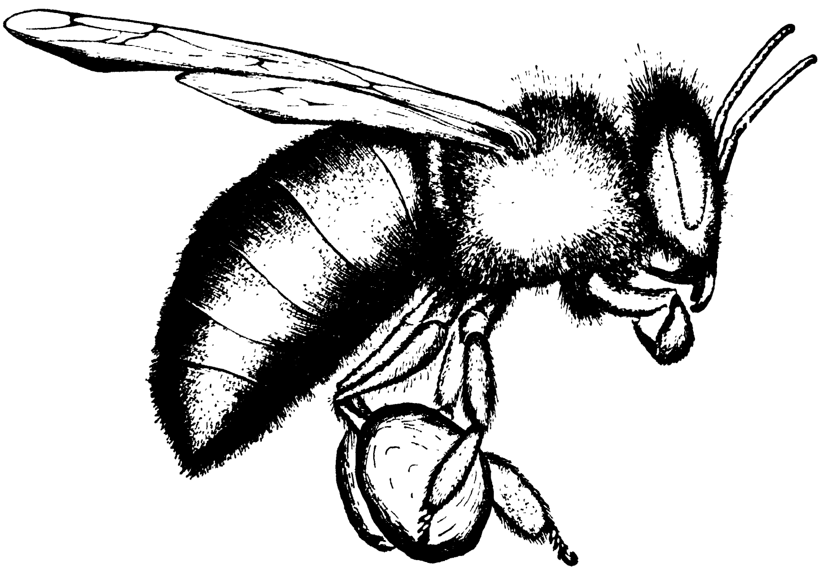


Fig. 6.—A bee upon the wing, showing the position of the middle legs when they touch and pat down the pollen masses. A very slight amount of pollen reaches the corbiculae through this movement.—Bulletin No. 121, Bureau of Entomology.

is found that this method yields wholly different results.

Chemical analysis shows that the liquid with which the pollen is moistened is chiefly honey or nectar recently gathered. In pollen taken directly from the anthers of corn the sugar content was 11 per cent, while in pollen from the pollen-baskets the sugar content was 28 per cent, showing that a large amount of sugar had been added. Since the pollen from the corbiculae contains three times as much reducing sugar as sucrose it is indicated that the liquid added is honey (largely a reducing sugar) rather than nectar, which contains more sucrose.

Honeybees make their collecting trips more frequently in the morning than in the latter part of the day. Young bees returning with their first loads are said to show great excitement, while the older bees move about leisurely. After a suitable cell has been selected, which may take some time, the bee grasps, according to Casteel, one edge with its forelegs, while the apical end of the abdomen rests on the outer side of the cell. The hind legs hang free within the cell, the pollen masses about even with its margin. The pollen masses are then forcibly thrust out of the baskets by the plantae of the middle legs. The bee then usually departs, leaving to another worker the packing of the pollen in the cell. The pellets are broken up and pressed downward, and sugar, with perhaps some liquid, is added to preserve them.

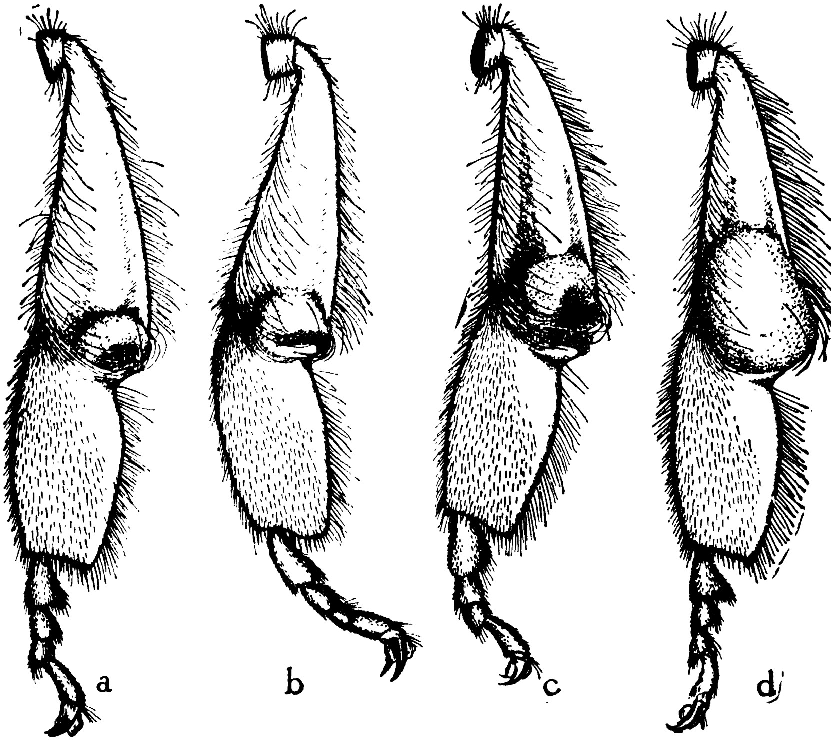


Fig. 8.—Camera drawings of the left hind legs of worker bees to show the manner in which pollen enters the basket. a, shows a leg taken from a bee which is just beginning to collect. It had crawled over a few flowers and had flown in the air about five seconds at the time of capture. The pollen mass lies at the entrance of the basket, covering over the fine hairs which lie along the margin and the seven or eight short stiff spines which spring from the floor of the corbicula immediately above its lower edge. As yet the pollen has not come in contact with the one long hair which rises from the floor and arches above the entrance. The planta is extended, thus lowering the auricle; b, represents a slightly later stage, showing the increase of pollen. The planta is flexed, raising the auricle. The hairs which extend outward and upward from the lateral edge of the auricle press upon the lower and outer surface of the small pollen mass, retaining it and guiding it upward into the basket; c, d, represent slightly later stages in the successive processes by which additional pollen enters the basket.—Bulletin No. 121, Bureau of Entomology.

Necessity of Pollen for Brood-rearing

Both the solitary and the social bees require pollen for brood-rearing, and

would speedily perish if deprived of it. Alone among insects, the existence of this group depends on an ample supply of pollen.

If honeybees are confined and fed only on sugar syrup they will live for a long time, build comb, and, since they void no excrement, will not require a flight in the open air, but they will rear no brood. Pollen is a necessity for the life of the colony, and it is for this reason that honeybees are equipped with the elaborate apparatus previously described, and gather it so diligently from spring till fall. In storing pollen preference is given to the cells immediately surrounding the brood. In very late fall it is common to find large quantities of pollen packed firmly in cells but not protected in any way; in other cases it is covered with honey and the cell capped over. To provide sufficient pollen is a vital problem to both bees and beekeepers.(For further information, see Fruit Blossoms, particularly matter on page 333.)

Necessity of Pollen for Young Bees as Well as for Maturing Brood

It was formerly believed that pollen was required for the preparation of a food for brood rearing only; but this has now been shown to be a mistake. Mykola H. Haydak, referred to further on, gives the results of some work he did at the Bee Culture Laboratory, U. S. Department of Agriculture in 1931. He writes:

The Role of Pollen in Life of the Honeybee

It is an accepted fact that bees eat pollen in order to produce the royal jelly, necessary food of the bee larvae.

When a young individual grows, there are changes in its weight and size. The growth of a young animal is also manifested by an increase in the quantity of muscles. One of the characteristic constituents of the latter is nitrogen. Therefore when an animal grows the nitrogen content of its body increases with the age. In other words, the changes in the nitrogen content may serve as an indication of the growth processes in a young living being.

It was found that old bees have more nitrogen than young ones. However, this could be ascribed to a certain amount of pollen consumed by older bees and still present in their digestive tracts in the time of these determinations. In order to find out whether this is the case, experiments were undertaken at the U. S. D. A. Bee Culture Laboratory.

Young bees were marked at the time of emergence, and added to a normal colony in the beeyard. Every successive day 20 marked bees were taken out of this colony. Ten of them were weighed and used for the nitrogen determination of the whole bees. Other 10 were decapitated, their digestive tracts removed by pulling out the whole intestines with the last abdominal segment and the thoraces and abdomens separated. The nitrogen content of those parts was determined separately. The nitrogen content and weights of the intestines were found by computing the difference between the nitrogen content of the whole insect and the sum of the weights and the quantities of nitrogen in the head, thorax and abdomen.

The results of these determinations are presented in the following tables:

Table 1. Changes in the nitrogen content during the life of the honeybee.

	Weight of nitrogen in milligrams.			
Age of bees.	Head.	Thorax.	Abdomen.	Whole bee.
Emerging ...	0.27	1.20	0.25	1.98
1 day	0.30	1.30	0.25	2.38
2 days......	0.33	1.32	0.30	2.37
3 days......	0.40	)1.40	)0.35	)2.79
4 days......	0.44	)	)	)
5 days......	0.52	1.65	0.44	3 25
6-20 days..)	0.46	1.65	)0.41	)3.19
21-38 days..)		1.72	)	)

Table 2.—Changes in weight and nitrogen content of alimentary tracts.

	In milligrams.		Increase in nitrogen content from time of emergence in pct.
Age of bees.	Wt	Nitrogen.	
Emerging	53.3	0.24	.....
1 day	26.4	0.53	121.0
2 days	26.3	0.42	75.0
3 days	48.2	0.51	113.0
4 days	50.3	0.86	258.0
5 days	67.6	0.87	263.0
6 days	69.2	0.83	246.0
7 days	68.7	0.91	279.0
8 days	72.4	0.96	300.0
9 days	65.2	0.81	238.0
10 days	46.0	0.75	213.0
12 days	53.5	0.52	117.0
17 days	...	0.51	113.0
21 days	...	0.31	29.0
31 days	32.2	0.25	4.0

As you can see, the nitrogen content of the bees 5 days old was greater than that of emerging bees, namely; by 92.6 per cent in the heads; by 76.0 per cent in the abdomens, by 37.5 per cent in the thoraces, and by 64.1 in the whole bees. The nitrogen content of the thoraces of bees 20 days old was even greater than that of bees 5 days of age. This was due to the fact that the flight activities of bees do not begin until later in life and an increased nourishment and strengthening of the thoracic muscles brought about an increase in the nitrogen content of this part of the bee body.

The nitrogen content of the alimentary tract corresponded closely to the quantity of pollen in the rectum. The largest content of nitrogen in the intestine was found in bees 8 days old. After this time the nitrogen content of the alimentary tracts decreased which signified that the play flight took place around the 8th day after emergence.

These facts demonstrate that young bees need to eat pollen not only for the production of the larval food but also for the growth and development of their own bodies.

Ground Grain Pollen Substitutes

In the absence of flowers honeybees will gather many other substances as substitutes for pollen. In early spring they may often be seen in large numbers resorting to sawdust heaps, and collecting fine particles of wood, which contain a certain amount of nitrogenous matter. They also gather at times the spores of fungi, which are very similar in composition to pollen grains. In Michigan they have been reported as gathering loads of fine black earth from the swamps, and they have been known to collect even coal dust.

At times also when there is a scarcity

of pollen bees will raid barns, stables, and chicken-houses to obtain bran or meal. There have been numerous reports of their invading the premises of farmers, stinging the cattle and driving them out of the stables and causing general annoyance. One can put out meal of some sort to call off the bees from the farmer's premises, but it has little value otherwise. As it has been known for many years that in spring-time bees will gather the flour or meal of different kinds of grain, it was formerly believed that we could feed ground grains to advantage.

There is no doubt that these substitutes will stimulate egg-laying. The fact that egg-laying can thus be stimulated has led many beekeepers to jump to the conclusion that the use of ground grains must be desirable. But careful observation of the effects of feeding such pollen substitutes, especially in regions where there are pollen famines, seems to show that they not only are not beneficial, but may be harmful. In the tupelo section of Florida along the Apalachicola River there is plenty of pollen until about June 15, but after this date there is little or none for nearly 90 days, or until September, for the tupelo furnishes very little. The colonies become very weak and the queens cease laying. It is the practice of some beekeepers after the flow from tupelo is over to move their bees northward to a locality where natural pollen is more abundant, and where it remains for the balance of the year.

In Australia pollen famines are as regular as the seasons themselves. There is a "critical period" in midsummer when the pollen fails, the queen ceases to lay eggs, and the brood dies of starvation. This shortage is due to the failure of the gum-trees, or Eucalypti, to produce much pollen. So small is the supply that colonies working on yellow gum dwindle down to mere handfuls, although there is a fine crop of honey. Beuhne says that he has used all kinds of grain substitutes in large quantities; but, although hives were well filled with brood, the bees thus raised were lacking in vitality and were short-lived. He has never been able to obtain a strong force of field bees. In Connecticut Latham states that as the result of years of observation he believes that the ground grains do more harm than good. One season strong colonies were fed freely with cottonseed meal; but when examined a month later they showed clearly the futility of feeding such substitutes, for they not only showed no advances but were actually weaker in bee strength. Out-apiaries which never received any meal invariably contained stronger colonies than the home apiary which was fed. Feeding meal in early spring apparently causes the bees to fly out and waste away in cold weather, when they had better remain quiet; retards building up later on; and injures their digestive powers. The weak bees and brood thus obtained lessen in the end rather than add to the strength of the colony. In the course of centuries bees have become adapted to the use of natural pollen, and it is not surprising that neither the nurse bees nor the larvae can digest meal equally well.

Fresh Whole Milk Sweetened, a Real Pollen Substitute

It may be safely concluded from the foregoing that pollen substitutes consisting of ground grains are not only useless but harmful. The obvious remedy is to lay in reserve combs containing pollen that the bees have stored. A comb of pollen is worth many more times that of a comb of honey. But as already pointed out, there are some localities that are deficient in pollen. The only thing then to do is to move the bees temporarily into a region where there is plenty of pollen. This however, is expensive. The bees have to be moved out and then back again as has to be done in the Apalachicola regions. If a substitute could be found that would develop real brood-rearing, it would prove a boon to some beekeepers.

Some work has been done by Mykola H. Haydak of the Department fo Economic Entomology and Agricultural Chemistry of Wisconsin that gives promise of at least partial if not entire success.

In an article in Gleanings in Bee Culture for January, 1934, page 32, Mr. Haydak after recording the unsuccessful work of others, writes:

> For the purpose of the present work it was necessary to obtain in considerabe quantities young bees which had never eaten pollen. While working in the United States Department of Agriculture Bee Culture Laboratory, the writer found that the vast majority of bees start to eat pollen between 12 to 18 hours after emergence. Only a few bees 12 hours old were found to have pollen in their mid-intestines. Therefore, the following procedure was adopted:
>
> Several combs with sealed brood in which pupae were just ready to emerge were placed in a hive in a constant temperature chamber adjusted to 33° to 34° Centigrade. Young bees were allowed to emerge during six and ten-

hour periods. After each such period the hive body with the combs were taken to a greenhouse and the young bees were brushed into a hive located in an isolated compartment.

The bees ate the food given to them and were unable to secure any other from the outside. The following food materials mixed with honey were used: skim-milk powder, dried yeast, fresh whole milk, egg white, egg yolk, whole egg, and rye flour. A colony in which emerged bees were fed pollen and honey was held under the same conditions to serve as a control.

Comparative Results of Various Pollen substitutes

For a better understanding of the results secured, a system of indexes was used which gave a comparative figure between all the foods. An examination of all indexes for the points investigated shows that the most valuable pollen substitute tried was dried yeast. Fresh whole milk and skim milk powder follow it with about one-half and one-third, respectively, of the value of pollen as a bee food. Whole egg and egg yolk have about one-fifth of the value of pollen. Egg white is about one-seventh as effective as a bee food as is pollen, and rye flour is almost worthless as a pollen substitute for bees.

Conclusions

The following conclusions were made from the results of these experiments:

1. Young bees developed their bodies to an approximately normal extent when fed with dried yeast, fresh whole milk, skim milk powder, whole egg, egg yolk, and egg white, instead of pollen. Rye flour did not produce a satisfactory development of the bee body.
2. The mortality of bees fed with various pollen substitutes varied to a great extent, the largest being in the colony fed with rye flour (52 per cent), and the lowest in that fed with the dried yeast diet (15.47 per cent.)
3. Brood was reared by all the experimental colonies, except that fed with rye flour.
4. The young bees produced by all the experimental colonies under investigation were in general equally well developed.
5. A certain increase in the nitrogen content of the young bees was necessary before they started to rear brood. This increase in the experimental bees was better than 30 per cent.
6. Young bees which were under-developed, due to lack of suitable nutrition, were found to be able to restore their bodies to a normal limit as soon as they received proper food. This phenomenon is of great biological significance.
7. The quantity of the brood reared varied widely. The largest quantity was in the dried-yeast-fed colony and the smallest in the one fed on egg white, but in both these cases it was less than in the control.
8. Death of pupae in the stage just before changing to adults was observed in all, except the control and dried-yeast-fed colonies. The greatest death rate was observed in the colony fed on egg white.
9. It was noted that bees fed on fresh whole milk built out foundation more rapidly than any of the others. This is in accordance with facts presented in literature.
10. The use of fresh whole milk sweetened with sugar as a satisfactory pollen substitute may be recommended. It is the cheapest, most common, and most conveniently prepared as a bee food. Sour (not putrefied) milk is apparently harmless to bees.

It is suggested that those who are in a locality where there is a deficiency of natural pollen try first fresh milk sweetened with honey and then try dry yeast.

Discarding the feeding of grain substitutes as of no benefit, or injurious, the only practical method in most instances of meeting a dearth of pollen would seem to be the giving of combs of pollen. It is often as important for beekeepers to reserve surplus combs of pollen as it is combs of honey. Not infrequently, especially in localities where pollen is very abundant, combs largely filled with pollen can be removed from the hive without apparent disadvantage. Bees without queens are said also to store large quantities of pollen. Such combs stored in a dry room would keep for a long time, and, introduced into the hive as required, would often make a great difference in the season's results.

Pollen in the Combs and Section Boxes

When pollen or meal is brought into the hive it is usually packed in cells as near the brood as possible. If the hives are opened in spring, pollen is found scattered more or less through all the brood-combs; but the two outside combs on each side of the hive are often a solid mass of pollen. Should there be a few stormy days the supply will disappear with almost unaccountable rapidity, so great is the demand for it in brood-rearing. As soon as it is wholly consumed brood-rearing must stop, although the queen may continue to lay eggs. It is most important, then, that there should be an ample stock of pollen during unfavorable weather, in order that strong colonies may be obtained.

Complaint has been made by those who use shallow hives that pollen is sometimes stored in the sections. It has been claimed that this can be prevented by placing a comb of pollen in the brood-chamber, though this was questioned by C. C. Miller. But this practice will usually induce the storage of more pollen below the sections, even if it does not keep them wholly free from it. In hives with the brood-nest as deep as the Langstroth it is very seldom that pollen will be found in the sections. It is in hives having less depth that there is danger.

The necessity of pollen as a winter food will be shown under Wintering.

POLLEN-DANCE OF BEES.—See Bee Behavior, subhead Joy Dance, page 66.

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POLLINATION OF FRUIT BLOOM.--See Fruit Blossoms.

POUND PACKAGE OF BEES.—See Package Bees.

PRIORITY RIGHTS.—See Overstocking.

PROFITS IN BEES.--This question is a hard one to answer, as so much depends on the locality, the number of colonies, the man, and the number of bees to the area.

Considering the average production of the poor and the good beekeepers in the northern states, in what is known as the rain-belt, one might perhaps expect to get from 40 to 75 pounds of comb honey, and perhaps from 35 to 50 per cent more of extracted. There will be some seasons when he might secure as much as 200 pounds or more on an average, and occasional seasons when there would be no surplus of comb or extracted, and the bees would require feeding. Taking one year with another, the ordinary beekeeper ought to average about 50 pounds of comb honey, on a conservative estimate, provided he has reasonable skill and love for the business. The comb honey might net him, deducting the expense of selling, from 10 to 15 cents; the extracted, from 7 to 12. If the honey is sold in car lots the figures per pound would be much less; but the expense of selling would be much less also. These figures do not include the labor of producing the honey nor the cost of the fixtures. The cost of the equipment, exclusive of sections and foundation, ought to be sufficient to last 20 years if no increase is made. Suppose the comb honey be put at 50 pounds as the average, and the price secured 15 cents net. The price secured would be $7.50 per colony; but out of this he must deduct a certain amount for labor, and 10 per cent on the cost of equipment, to be on the safe side.

With only a few bees the labor need not be considered, as the work could be performed by some member of the family, or by the man of the house, who could, during his spare hours, do a little with bees, and work in his garden. In case of one, two, or three hundred colonies, the labor item must be figured. The larger the number crowding the available territory, the smaller the profit per colony. A rough estimate for an apiary in a locality not overstocked, not including the labor on the $7.50 actually received for honey sold, ought to leave a net profit of somewhere about $5.00. This would be on condition that the locality did not require much feeding in the fall. If feeding was found to be necessary, 50 cents more might have to be deducted, making a net profit of $4.50. On this basis it will be seen that the profit in one season ought to pay for the hives and supers in two years, or come very close to it, leaving the investment good for ten or more years. If it is figured that way the ten per cent need not be added. For a professional man, or one who has other business, even these returns are good; for if he secures only enough for family use, the diversion or change to relieve the tired brain is worth something.

The question as to whether one should keep few or many bees will depend upon many conditions; but the principal one is the ability of the man. Many a person can handle a few chickens, and get good results; but when he runs the number up into the hundreds he meets with failure. Some have done remarkably well with a few colonies; but when they have attempted to double or treble the num-

ber they fail or make only a small profit.

Many years ago a neighbor cleared a thousand dollars from one acre of onions. It made him wild. He bought ten more acres of the same kind of onion land, going into debt for it, and expected to clear the following year $10,000. When he managed the one acre he did all the work himself; but when he worked the ten acres he had to hire help. The help was incompetent, or did not understand. Onions fell in price; and at the final round-up that year he had a great stock of poor onions without a buyer. They rotted. He became discouraged, and lost all he had.

A few persons, on account of a lack of experience or perhaps business ability, not understanding their own limitations and those of their localities, will plunge into beekeeping too deeply and meet with disaster.

Many a beekeeper has done well with four or five hundred colonies when he fails with twice that number. When he or members of his family can do all the work everything goes well; but when he has to hire help, much of it incompetent, his troubles begin, and his profits are cut in two. Said one large producer, "When I had 3,000 colonies, and my boys and I did all the work, we made money; but when I increased my number to 7,000, and hired help, I actually did not make as much money as when I had 3,000."

There are some men who are unable to get along with their help. There are others who, when they have good help, have no ability to plan work for others.

If it were not for bee disease and robbing, the question of hired help would not be so serious. A poor man in a beeyard may make his employer a world of trouble and expense unless his boss can be with him constantly, and that is not always possible.

One may double or treble the number of his colonies if he can plan his work ahead and then go along with the help, taking one yard after another. After a time one of the men may be competent enough to go to the yards and manage the other help; but usually a good man can make more money by running and owning the bees himself than by working for some one else. It is difficult, therefore, to hold such a man.

Assuming that the help question can be solved, let us look at the side of expansion of the business. Let us assume a case. Here is a beekeeper who has 300 colonies. During the busy season he is comfortably busy. But during six months in the year his time is not very profitably employed—a distinct loss; for it will take him only a short time, comparatively, to get his supers ready for the next season, nail his hives, repaint them, or do other preliminary work that can easily be done indoors; and yet his interest or his rent and his living expenses are going right on. Suppose, for example, that this beekeeper has 600 colonies, or 1,000; that he has good business ability; that he has plenty of bee-range. Suppose he scatters this number in 15 different yards, none further than 15 miles from his home, and a good part of them not over four or five miles away. In the busy season he will, of course, have to employ help. If he has the right kind of executive ability he will see that help is profitably employed. When the rush of work is over he will look after the marketing of the crop, put the bees into winters quarters, perhaps doing the work himself with the occasional help of one man and a machine. In cold weather he can devote part of his time to preparing for the next season and the rest of the time to selling the crop. While he is operating 1,000 colonies it costs him no more to live; the same automobile that will carry him to two or three hundred colonies will carry him to the other seven or eight hundred. If he is running for extracted honey, the same extractor, uncapping-knives, and smokers can be used at a central extracting-station. He is thus enabled to put his invested capital where it will be earning money for him all the time in the busy season instead of eating up interest part of the time.

PROPOLIS (From the Greek; pro, before, and polis, city, referring to its use in partially closing the entrance or gateway to the bee commune or city).—Propolis is a gum gathered by bees from a variety of plants, but especially from the buds having some sort of gum or sticky substance. As it occurs in the bee hive, it is from a yellow to a dark reddish-brown in color, and resembles the pitch of commerce. It has an aromatic odor similar to that of the buds of the balm-of-Gilead, is extremely brittle when cold, melts at about 150° F., is partly soluble in alcohol, only slightly soluble

in turpentine, but readily dissolves in ether and chloroform. When wax and propolis are melted in the same receptacle the liquid wax, being of less specific gravity, rises to the top and the liquid propolis sinks to the bottom. Propolis quickly sinks in water. (See Wax, subhead Wax Rendering.)

Method of Loading in Pollen Baskets

Bees collecting propolis from pine and other sources have been observed on a few occasions. The bees obtained their material from drops of resin appearing on the bark of the tree on both trunks and branches. A bee alights close to such a drop and with the mandibles it tears loose a piece of it which, on account of its

Fig. 1.—Propolis drop on hind leg of bee collected from pine.

stickiness, strings out, forming a thread that finally separates from the original drop. Such threads are removed from the mandibles with the claws of the second pair of legs then brought backwards and deposited in the pollen baskets. With the inner, surface of the metatarsi of the second pair of legs the thread of resin is now pushed into the right position and molded to the shape of a heap of pollen. This operation is repeated several times until a comparatively large drop of propolis adheres to each pollen basket. After each tearing loose and the deposition of a thread of propolis a worker bee takes off for a short flight, returning to its original place after a few seconds and continues loading up.

Help Needed in Unloading Propolis

On returning to the hive a bee never disposes of the propolis by itself. Hive bees tear the drops loose with their mandibles in the same manner as the field bee tore the threads from the bark in the fields. It appears to be a hard piece of work and an enormous strain for both the collector and the bees doing the removing work. These bees take a firm hold with their legs on the supporting surface while their mandibles are buried in the propolis. They pull with such effort that the collector often fails to hold on and is pulled away from its position.

Quite frequently propolis collectors do not enter the hive but they are freed of their burden outside on the alighting board. During this removal process it often happens that little pieces or entire heaps of propolis accidentally are dropped and stick to various places on the hive. The bees, however, don't seem to take the effort of removing them. This accounts for the many droplets of colored transparent propolis which appear in many places in a bee hive which do not seem to serve any particular purpose. The hive bees after obtaining the propolis carry it with their mandibles to the place where it is needed and apply it there by using their mandibles. The tongue is not used for either collection or application of propolis.

Can Be Handled Only When Warm

Temperature seems to play an important part in the process of collecting propolis. High temperatures always soften waxy and resinous substances, making

Fig. 2.—Propolis drop on hind leg of bee collected from poplar.

them more plastic and naturally more easily gathered and handled. This may partly account for the large amount of propolis brought in in any season. Propolis collec-

tors are not observed in the early morning hours. They appear first around 10 a. m., and as time advances and temperature rises, their number increases steadily. Toward evening less and less loads of propolis come in.

Sometimes in the evening bees can be observed on which the propolis removal could not be successfully finished. On such bees one or both hind legs bear a stick-like projection, consisting of propolis which hardens while being removed. Such bees were marked to find out the fate of these propolis sticks. Bees marked on such occasions did not join the field forces the next morning, but remained inactive on the alighting board, sunning themselves. Later in the day around noon, they appeared free from their stick-like appendages and flew back to their work. This appears as if the sunshine helped to re-soften the hardened propolis to make its removal possible.

How Bees Use Propolis

Bees do not pack propolis in the cells, but it is applied at once to some portion of the hive. When newly gathered it is very soft, and in an almost liquid state is forced by the bee's tongue into cracks and crevices, or spread as a varnish over the surface of combs. It is found in every part of the hive, but is especially abundant around the edges of the cover and at the ends of the frames, often completely filling the space between the ends of the top-bars and the front and back walls of the hive. It occurs in many parts of the hive where it is entirely useless, as on its wall, bottom-board, middle of the cover, and on the frames and sections. In some cases it is found in pellets or small masses, in others in narrow bands. It is stated that empty combs, which are not immediately used for brood-rearing or honey, are given a thin coating of propolis to preserve them. The spaces between the wires of queen-excluders are often partially filled with propolis, but wax is also used for this purpose and is often covered with propolis.

How to Check Propolis

English beekeepers check propolizing by rubbing chalk over the edges of frames and covers, and whitewashing the interior of the hive is sometimes practiced for the same purpose. Vaseline or grease is smeared on parts of hives and frames that come in contact. Bees will not propolize where there is oil or grease. It is seldom, however, that any measures to prevent propolizing are used.

Small animals which enter the hive are stung to death, and are then sealed up in a shell of propolis. Snails, lizards, mice, and even small snakes, have been embalmed in an impervious coating of glue.

If sections are left on the hive too long the bees will not only cover the woodwork but will also varnish over the whole surface of the white cappings, rendering the honey almost unsalable. The best course is to take off the supers as soon as the sections are capped over, for during a strong flow of honey little propolis is gathered. But it is almost impossible to keep the sections entirely free from it. The sections should be so packed in the supers as to leave few crevices and no more surface than necessary accessible to the bees. The outside of the sections may be covered entirely by using holders having the top and bottom of the same width as the section frames. Or, where the tops of the sections are exposed, a coat of hot paraffin applied with a brush will keep the sections clear of propolis. Propolis may be readily removed from the boxes and from the edges of the sections with sandpaper. (See Comb Honey, How to Produce.)

The quantity of propolis brought into the hive depends partly upon the race of bees, and partly upon the location. Caucasian bees use propolis much more freely than the Italian or Carniolan race, and may nearly close the entrance to the hive with pillars or buttresses, between which are left spaces so narrow that only one bee can pass at a time.

Source of Propolis

In Colorado the narrow-leaved cottonwood (*Populus angustifolia*) furnishes so large an amount of propolis that a grove of these trees near an apiary is an objection. The gum is of a bright reddish color, and exudes on the buds in such large quantities that a bee can obtain several loads from a single bud. The bees continue to gather this gummy substance long after the leaves have fallen.

In the East the buds of the balsam poplar (*Populus balsamifera*) are believed to be one of the chief sources of propolis. The larger buds usually have on the ends small drops of yellow gum.

When Gathered

While propolis may be gathered at any time during the summer, it is gathered

most largely in the fall, when the bee's instinct impels it to prepare for cold weather. During the honey flow very little if any propolis is brought in. In the absence of a natural supply of propolis bees may gather a supply from the parts of old hives, where it has been softened by the heat of midsummer. Dadant relates that in the vicinity of Matamoras, Mexico, where propolis seemed to be scarce, he saw bees collecting green paint from window blinds and pitch from the rigging of a vessel in the harbor. Bees are attracted by the smell of varnish and will alight on a newly varnished object in large numbers. The superstition, formerly prevalent, that bees in sorrow for the death of the beekeeper, would follow his body to the grave, probably gained credence from instances where bees were seen working on the varnish of the coffin.

How Propolis May be Removed

A small quantity of propolis may be removed from glass with alcohol. Frames and separators may be wholly or partly cleaned by dipping in a wash-boiler filled with boiling water and lye. While the separators will come out entirely clean, it is usually necessary to scrape the wooden frames. With a large boiler many frames and separators may be cleaned at one time; supers and hives may also be cleaned in the same way. Propolis may be prevented from sticking to the fingers by the use of vaseline, or oil, or by a pair of light cotton gloves. It can easily be removed from the hands with gasoline or lye.

Propolis Unnecessary in Modern Apiculture

Under the conditions of modern bee culture the collection of propolis is apparently useless to the bees and a disadvantage to the beekeeper. The various parts of the hive are glued tightly together so that they are removed with difficulty; the combs are frequently stained a dark color; and the sealing of all crevices may prevent proper ventilation, causing the interior of the hive to become damp, and ice to form in cold weather. But in the early history of the honeybee, long before the beginning of beekeeping, when honeybees built their nests in hollow trees or in cavities in the rocks, the use of propolis was undoubtedly of great benefit both in excluding rain and cold, and also ants. Although no longer beneficial under proper methods of beekeeping, the habit still survives; and, when bees are not engaged in gathering nectar, they still continue to seek for gums and resins.

Propolis an Antiseptic for Surgical Dressing

Propolis is the base of an important antiseptic preparation used by surgeons. In a hospital where 58 surgical cases were treated with Propolishinvasogen (Pearson & Co., Hamburg) there was not a single failure. The results were much less favorable in cases where this preparation was not used. It is highly recommended as a domestic remedy for wounds and burns.

It is also claimed that it makes an excellent polish for wood and leather.

Q

QUEENS, FERTILIZATION OF.—See Fertilization of Queens.

QUEEN-REARING.—Before this subject is read the one on Queens, further on, should be gone over carefully. This will make queen-rearing more easily understood. Unless this is read first what is said here may not be understood.

As a general rule, extensive honey-producers believe that it is better and cheaper to buy their queens than to attempt to raise them, for the following reasons: (1) When they buy queens they introduce new blood into their yards; (2) to raise good queens requires skill as well as considerable time and equipment, which, if devoted to the production of honey, would yield larger results in dollars and cents; (3) there is often a predominance of

the poor drones in their locality, so much so that their matings would produce hybrids. There are other large producers who do raise some queens of their own, such stock coming from colonies showing the best average in honey production year in and year out. When swarming is controlled by killing the queen, requeening can be effected without very much loss of time. Moreover, the good cells can be reared during the swarming season, but such cells are not quite the equal of supersedure cells.

Conditions Favorable and Unfavorable for Rearing Queens

Bees will build queen-cells and rear young queens when preparing to swarm (see Swarming), when superseding an old, failing queen, or when their queen is lost through accident or removed by the beekeeper.

It is generally held that the best queens are reared when the bees are about to supersede an old queen soon to fail. At such times one may see large beautiful queen-cells, looking like big peanuts, projecting from the side of the comb. The larvae in such cells are lavishly fed with royal jelly; and when the queens finally emerge they are usually large and vigorous.

Supersedure Cells

When the queen is two or three years old she may show signs of failing. The bees recognize the fact that their own mother will soon die, or at least need help from a daughter, and very leisurely proceed to construct a number of cells, all of which are supplied with larvae, and fed in the same lavish way as those reared under the swarming impulse.

Unfortunately one can never determine in advance when the bees will rear supersedure cells, and it may be true that the queen about to be superseded is not desirable stock from which to rear. In like manner cells reared under the swarming impulse, if from poor stock, should be rejected, because it is certainly unwise to rear queens from any thing but the very best stock.

Swarming Cells

During the swarming season one can select cells from colonies headed by his best queen or queens, and place these cells in queenless nuclei from which the virgins, when they emerge, can take their mating trips. The queen, when laying, can be held in these nuclei, to be introduced to colonies where the queens are defective, or where they are more than two years old and should be replaced.

In the same way one can use supersedure cells and raise good queens, provided, of course, that the failing queen already in the hive is of good stock, and has formerly been the mother of a strong colony.

While one can requeen a colony by killing the old queen and letting the bees raise another, the process is expensive and wasteful. Queens raised at such times, unless under the supersedure impulse, will, as a rule, be inferior.

HOW TO RAISE A FEW FOR ONE'S OWN USE

Where one desires to raise a few choice queens before or after the swarming season, he can do so without any special equipment or apparatus. Perhaps the simplest plan for the man who runs his bees for honey or pleasure is the one that was used by Dr. C. C. Miller, and recommended in his book, "Fifty Years Among the Bees." The plan in brief is as follows:

First of all, it is important to select the best queen in the yard, one that has had a record for two years back. It is not always possible to determine the value of a queen by one year's testing. A queen for breeding purposes, should produce bees of pure stock, uniformly marked, one whose bees are hardy, good workers, that have a record for producing large yields of honey. Sometimes the bees of a hybrid queen will produce more honey than one of poor stock, but as hybrids are a mixture of two races, the queens raised are liable to sport to black as well as yellow. (See Hybrids and Races of Bees.)

The queen selected should be kept in a two-frame nucleus well supplied with bees to conserve her energy. If she continues to be the mother of a powerful colony she will not last long. As we wish her to give us a fresh batch of eggs for breeding purposes every now and then, we will confine her to a two-frame nucleus throughout the period that queens are to be reared, and where her egg laying will be limited.

By turning to the subject of Queens it will be noticed that queen bees are structurally the same as worker bees, both coming from female eggs, or young larvae; or, to put it another way, an egg

from a worker cell or a young larvae from such a cell can be made to produce either a worker bee or a queen bee. If the bees decide to rear a queen they will build a royal cell around her and feed the young larva lavishly with royal jelly during the entire period of her growth, while if they wish to raise a common worker bee they will wean the larva by giving it a coarser food. (See Queens, also Brood and Brood-rearing.)

In order to rear a queen, then, it is necessary to have a number of young larvae about one day old, for which the bees are to build cells. When the conditions are right the bees will build queen-cells. Those conditions are, first, queenlessness, swarming and supersedure impulse. In the last two the bees already have a queen, but have in prospect raising another. In all three cases the bees select young larvae or eggs from which to rear queens.

We will now go back to the nucleus containing our breeding-queen. We remove one frame of brood and bees, being careful not to take the queen. Shake the bees back into the nucleus, and in place of the frame removed put an empty frame containing two strips of comb foundation about an inch wide, and about five inches long. These two strips of foundation are fastened vertically to the top-bar and so placed that the distance between each strip of foundation and the end-bars will be about equal. The nucleus should be fed, if no honey is coming in, so that these strips will be gradually drawn out into combs, and as soon as the combs are drawn or partly drawn the queen will begin to lay eggs in them. The two strips of foundation will be drawn into new combs by the bees until the two sides meet. When the combined comb nearly fills the frame there will be a scalloped or irregular bottom edge. In a week there will be eggs and brood in all stages. At the end of this time remove the frame, brush the bees off carefully, and with a sharp knife trim the bottom edge of the comb to the irregular line of very young larvae that have just hatched from the eggs. It is right along this scalloped or irregular edge that we desire the bees to start cells.

If this comb were put back in the nucleus the bees would no nothing with it except to build on more comb, so we will now place it in a strong colony that has been made queenless three days. If honey is not coming in it is better to feed the colony a little every day. As the comb just built from foundation is soft and easy to work, and larvae of the right age are along the bottom edge, the bees will readily start a lot of cells along this edge rather than build cells in their old tough combs. Some queenless colonies will build more cells than others.

When one desires to get the greatest number of cells that are large and to have the occupants well fed, a colony prepared in the following manner will give better and bigger queens. Select some colony and make it queenless and broodless. Let it have a couple of frames of pollen, and, for every frame of brood taken out, put in a comb of honey, or even empty comb. If honey is not coming in at the time, feed the colony a little every day to keep it in a prosperous condition. Without brood or a queen, or anything from which they can rear a queen, the bees will be full of royal jelly and crying for eggs or young larvae from which they can rear a queen. After bees have been fed and have been queenless and broodless for four hours, the prepared comb containing the young larvae is put down in the center of this colony after removing the center frame. The bees will immediately commence rearing a large number of cells along the edge of the comb, feed the larvae lavishly, and in a few days, if feeding is kept up, will have a large number of good cells started. Feeding should be continued, and in about nine days this comb, with its cells capped over and completed, can be taken out, when the cells can be cut out one by one and given to nuclei that have been already prepared. (See Nucleus.) A count of the cells started will determine the number of nuclei that will be needed. These should be queenless, of course, and should be made up a day ahead, in the manner described under Nucleus.

Instead of having special nucleus boxes one can use an ordinary eight or ten frame brood-nest, put in a division-board, and one or two frames of brood and bees. When the nuclei have been queenless for about one day one can put a cell into each one of them. These cells should be handled very carefully, as they will not stand pressure. Make a dent in the side of the comb, and in this dent or depression place a cell pointing downwards. To hold it in place push a crate staple over it, the

two points going down into the comb until the staple comes in contact with the cell. Put the comb back into the hive, spacing the combs far enough apart so that the cell is not damaged. In a few days there will be a young virgin ready to mate. After the queens get to laying they should be kept in these nucleus boxes until it is necessary to use them in the stronger colonies. Kill the old queen and introduce the new one. (See Introducing.)

In many cases the ripe cells, instead of being given to nuclei, can be given direct to strong colonies made queenless twenty-four hours before. Where colonies need requeening this can be done very nicely without forming nuclei; but it is important to make the colonies queenless a day ahead of the cells being given as otherwise the bees might tear them down.

If one desires to rear queens in a commercial way he should send to the publishers of this work for a copy of "Modern Queen-rearing," by M. T. Pritchard, the most experienced queen-breeder in the United States; and if he wishes to go into the matter still further secure a copy of "Queen-rearing Simplified," by Jay Smith. Both of these books describe special apparatus, special tools and equipment for rearing queens in a large way with artificial cell-cups.

Grafting artificial cells is a very nice operation — almost a trade in itself. It may take a good part of the season to learn to do the trick successfully, whereas, if the Dr. Miller plan is used, good queens can be secured without much experience and without any expense for equipment.

The great difficulty in grafting is in the selection of larvae of the right age and in the placing of the same in the artificial cell cup so that it will lie on top of the royal jelly and not under it. Larvae should be about two days old from the hatching from the egg and when placed should lay flat on the royal jelly in a moon-shaped circle. To do either successfully requires an expert or inferior queens will be the result. The Dr. Miller plan gets over the difficulty. To describe these delicate operations would require more space than can be given here. Moreover, commercial queen rearing would interest only a comparatively few in the ranks of beekeepers and the few are referred to the above mentioned works.

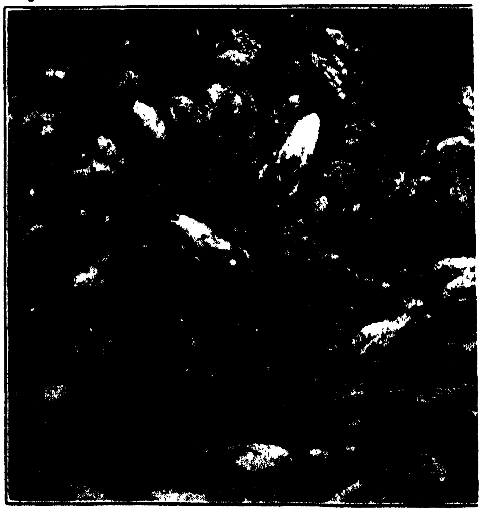
QUEENS.—The most important personage in the hive is the queen, or mother bee. She is called the mother bee because she is the mother of all the bees in the hive.

Structurally she is much like the worker bee except that her reproductive organs are fully developed, while in the worker they are only partially so. In appearance the queen has a longer body. The same egg that will produce a worker will also produce a queen. While a worker will lay eggs only under stress of abnormal conditions, and these only drone eggs (see Laying Workers), the queen bee, after she has met a drone (or male bee), will lay two kinds of eggs—worker and drone. The workers, instead of being neuters, are all females, but incapable of reproducing more females. So far from being a ruler or sovereign, the queen is little more than an egg-laying machine subject to the caprices of the worker bees.

When a colony is deprived of its queen, the bees set to work and raise another so long as they have any worker larvae or eggs in the hive from which to do it. (See Queen Rearing.)

Undersized or Imperfectly Developed Queens

Some laying queens are small and unusually dark in color, and yet become fer-



How bees will circle around their queen.

tilized. They lay eggs for a little while (from a week to several months), but seldom prove profitable. Sometimes they will

Queen, drone, and worker.

not lay at all, but remain in a colony all through the season, neither doing any good nor permitting any other queen to be either introduced or reared. A wingless queen, or one with bad wings, will prevent another from being introduced. The remedy is to hunt her out and remove her. When queens are so nearly like a worker bee as to make it hard to distinguish them, they can often be detected by the peculiar behavior of the bees toward them. See the cut on the opposite page. In the fall, after egg-laying has stopped, all queens will usually look small and insignificant, even though she be an extra good one. But if the queen looks small, during the laying season, when all fertile queens are laying, she should be removed.

Development of Baby Queens—How a Worker Egg is Made to Produce a Queen

This is a question that puzzles novices about as much as any question they can ask. To answer it let the following experiment be tried when the bees tell their own story: Get a frame of eggs, and put it into a colony having no queen. The tiny eggs will hatch into larvae. (See Brood and Brood-Rearing, pages 109 to 119.) As soon as they begin to hatch, there will be found a few of the cells supplied with a greater profusion of milky food than others. Later these cells will begin to be enlarged, and soon at the expense of the adjoining ones. These are queen-cells. They are something like the cup of an acorn in shape, and usually occupy about the space of three ordinary cells. In the cut on the next page will be seen cells in full state of growth. (See Queen-rearing.)

There are some queer things about queen-cells, as will be noticed. After the cell is sealed, the bees put a great excess of wax on it, make a long tapering point, and corrugate the sides something like a thimble. This corrugation, or roughness, when closely examined, will be seen to be honeycomb, or, rather, an imperfect representation of honeycomb on a very small scale.

It is very handy to be able to tell when any young queen will be likely to emerge; and the bees are very accommodating in this respect also; for, about the day before the queen emerges, or maybe two days, they proceed to tear down this peak of wax on the tip of the cell, leaving only a thin covering. No one knows why unless they are anxious to get a peep at their new mother. It has been said they do it that she may be better able to pierce the capping; but sometimes they omit the proceeding entirely, and apparently she has no difficulty in cutting the cap off. If the cell is built on new comb, or on a sheet of foundation, and is held up before a strong light at about the fifteenth day, or a little later, the queen can be seen moving about in the cell. Afterward, by listening carefully, she can be heard cutting her way out. Pretty soon the points of her sharp and powerful mandibles will be seen protruding as she bites out a narrow line. Since she turns her body in a circle while doing this, she cuts out a circle so true that it often looks as if marked by a pair of compasses. The substance of which the cell is made is tough and leathery, and therefore, before she gets clear around her circle the piece springs out in response to her pushing, and opens just about as the lid of a coffeepot would if the kitten should happen to be inside crowding against the lid. Queens may often be seen pushing the door open and looking out, with as much apparent curiosity as a child exhibits when it first creeps to the door on a summer morning; often, after taking this look, they will back down into their cradles, and stay some time. This is especially the case when other queens are emerging and there is a strife as to who shall be sovereign.

Royal Jelly

Up until recent years opinion was divided as to whether this was a partially digested food regurgitated or a secretion. The best authorities, and among them **Snodgrass, now hold to the latter view.** Whatever it is, it is so highly concentrated a food that a larva destined to be a queen and fed on it during its entire period of growth emerges from her cell in 16 days, while a larva destined to be a worker and fed on a coarser food after the first three days, emerges from its cell in 21 days. For the first three days the larva in both cases is fed on this royal jelly and up to that time the growth is the same. After that the continuance of this royal food makes a queen and after that the coarser food makes a worker. This is one of the wonders in a beehive—that a tiny egg may become a queen or a worker, according to its environment and its food. (See Brood and Brood-Rearing.)

What Does the Queen Do While Sealed Up?

The author has opened cells at every stage after they were sealed until the queens were ready to emerge. One day after being sealed they are simply ordinary larvae, although rather larger than worker larvae of the same age; after two or three days, the head begins gradually to be "mapped out," and later, some legs are seen folded up; last of all, a pair of delicate wings come from somewhere. (See Brood and Brood-Rearing.) Two days before emerging the author has taken them out of the cell, and had them mature into perfect queens, by keeping them in a warm place. He has also taken them out of the cell before they were mature, held the white, still, corpse-like form in the hand, then put it back, waxed up the cell by warming a bit of wax in the fingers and had it emerge three days after, as nice a queen as any. Mr. Langstroth mentions having seen the

Natural built queen-cells, life size.—Photographed by W. Z. Hutchinson.

whole operation by placing a thin glass tube, open at both ends, in the cell, so as to have it enclose the queen, the bees being allowed to cap it as usual. This experiment was made first by Huber. (See Observation Hives.)

What Becomes of the Queen After She Leaves the Cell?

After she pushes open that hinged door she generally begins by poking her head into the cells until she finds one containing unsealed honey, from which she takes a sip that at least indicates she likes that kind of provision.

After she has had her repast she begins to crawl about, partly to enjoy using the long legs and partly because she knows that it is her allotted task to tear down the remaining queen-cells, if such there are. If other queens have emerged before her, it is one of her first and foremost duties to look them up and fight it out. The queen that first receives the sting from her opponent crumples up and dies. The victor may in turn finally be stung. The strongest and usually the oldest finally becomes the reigning mother. When all other cells have been removed, as they usually are where queens are wanted for other purposes, the final victor has nothing to do but to promenade over the premise, monarch of all she surveys. If she ever sits down to take a rest, or takes a rest in any other position, during the first week of her life, the author has never been able to discover it.

But suppose she does find another cell—what then? She sometimes runs around awhile; sometimes the bees tear it down, and sometimes she tears it down herself, with the same strong mandibles that she used to cut her way out of the cell at first. She makes a small opening in the side of the cell, and the bees do the rest.

It is said that the queen immediately stings her helpless immature sister in the cell to make a sure thing of her destruction, but there is some doubt about this. Spots have been seen in the side of the queen that looked as if she had been stung. Such cells have been torn open, and nice queens matured from them. As these immature queens are very soft, the workers will soon pick them out of the cell, piece by piece. The author has sometimes placed them in an incubator and had them mature, minus a wing, a leg or whatever portion the mischievous worker had pulled away. From many observations the queen generally tears a hole in the cell, or bites into it in such a way that the workers tear it all down, much in the way they do any mutilated or broken pieces of comb.

When queen-cells have been cut out, all the larvae that are in any way injured are at once thrown out, and none but the perfect cells preserved. Bees never fuss with cripples, nor try to nurse any bee that is wounded or maimed. They have just the same feeling for their fellows that a locomotive might be expected to have for a man whom it had run over. They battle against anything that threatens the extinction of the colony. There are no signs of their caring for one of their number, or even having compassion on their helpless brood when it is wounded and suffering.

After the battle. By accident a batch of cells were left for a day or so too long in a cell-building colony. The first virgin that hatched, true to her nature, waged an unfair war upon her helpless sisters, still in their cradles. Every cell was ruthlessly torn open, and the little white queen inside killed. A virgin queen will not stand for competition. This inborn instinct of hatred against a rival does not end with youth. Two laying queens—old enough to know better—will usually fight if placed together even in strange and unnatural surroundings. Place two queens under a drinking glass in the hot sun. If they could reason, we might expect them to forget their hatred of each other in view of their common predicament of being confined away from the care of nurse bees. But the powerful instinct of hatred is so strong that they will usually fight—fight until one or the other is stabbed by that poisoned weapon that is never used except against a rival.

When a queen emerges, the remaining cells are very soon torn down, as a general thing, but there are many exceptions. When two queens emerge at about the same time they also generally attempt to kill each other; but both are not killed. This probably results from the fact that they can sting their rivals only in one certain way; and the one that, by strength or accident, gets the lucky position in the combat is sure to come off victorious. This explains how a very inferior virgin queen, that has entered the hive by accident may sometimes supplant an old laying queen. Two queens, when thus thrown together, generally fight very soon, but this does not always happen. Several cases are on record where they have lived in peace and harmony for months, even when they emerge at about the same time, and it is quite common to find a young queen helping her mother in the egg-laying duties of the hive, especially when the mother is two or three years old. If the season is good, and the hive populous, they may divide their forces after swarming occurs. (See After-swarming.)

Sometimes the queen will pay no attention to the remaining cells, but will let the young queens emerge, and then their "little differences" are adjusted afterward, either by swarming or by the usual "hand-to-hand" conflict "until death." Many losses in introducing queens have resulted from two queens being in the hive, the owner being sure his hive was queenless—because he had removed one. (See Introducing.)

Queen's Voices

Queens have two kinds of voices, or calls, either one of which they may emit on certain occasions. It is almost impossible, on the printed page, to describe these sounds. One of them is a sort of z-e-e-p, z-e-e-p, zeep, zeep. Some call it piping, others teeting. Whatever it is, it consists of a prolonged tone, or a long zeep, followed by several much shorter, each tone shorter than the preceding one. This piping is made when the queen is out of the cell, either virgin or laying, but usually by a young one. The older ones are generally too dignified, to give forth any such loud squealing; but they will squeal, and lustily, too, sometimes, when the bees ball them and grab them by the legs and wings.

The other note that queen bees are known to give forth is called *quahking*, for that more nearly describes the actual sound than any other combination of letters that can be put together. It is emitted only by a young queen in the cell, before she emerges, and is made in answer to the piping, or zeep, zeep, of one of the virgins that has already emerged, and is trying perhaps to proclaim aloud her sovereignty. The quahk will be heard, then, only when there are queen-cells in the hive.

While a young queen is being introduced she frequently utters a note of alarm a zeep, zeep, etc. The bees are nearly always stirred by these notes and they will often run after her and cling around her like a ball when they would have paid no attention to her had she not uttered this well-known note. (See page 76, Balling Queens.)

Queens, when placed near together in separate cages, will often call and answer each other in tones that are probably challenges to mortal combat.

Some queens received one summer from the South called so loudly when placed on the table that they could be heard the entire length of a long room. One voice would be on a high, shrill key, and another a deep bass, while others were intermediate. On watching closely a tremulous movement of the wings was noticed while the queen was uttering the note, and one might infer from this that the sound is produced by the wings, but this is probably not the case. Some one reported having heard a queen squeal, both of whose wings had been entirely clipped off.

Virgin Queens

The newly emerged queen is termed a virgin, because she has not met a drone and to distinguish her from queens that have been fertilized and are laying. Virgin queens, when first emerged, are sometimes nearly as large as a fertile queen, but they gradually decrease in size until, when three or four days old, they look so small and insignificant that a novice is disgusted with their appearance, and, if hasty, pronounces them useless. For the first week of their lives they crawl about much as an ordinary young worker does, and it is often very difficult, if not almost impossible, to find them unless an amount of time is taken that is more than a busy apiarist can well afford to spare. It is a waste of time to look for them. It is bet-

ter to insert a frame having some unsealed larvae just hatched from the egg; then if no cells are started one can decide the queen is there without looking further. This plan answers a threefold purpose: It enables one to tell at a glance whether the queen is in the hive all right or not; for as soon as she is lost they will start more queen-cells on it; it also enables the bees to raise another queen in case the former queen is lost by any accident on her wedding-flight, which is frequently the case; and, lastly, it serves as a sort of nucleus to hold the bees together and to keep them from going out with the queen on her wedding-trip, which they are much disposed to do, if in a small nucleus containing no brood. Unsealed brood in a hive is a great safeguard against accidents of all sorts.

Age at Which Virgin Queens Take Their Wedding-flight

Some fix the wedding-flight from two to ten days after birth. It is probably seldom before the fifth day. Some difference, doubtless, arises from the fact that queens often stay in the cell a day or two after they are strong enough to leave it. Sometimes a queen will be found walking about the combs when she is so young as to be almost white. Beginners will sometimes rejoice at their beautiful yellow queens, saying that they are yellow all over, without a bit of black on them; but when looked at again, they will be found to be as dark as the generality of queens. At other times when they come out of the cell they will look, both in color and size, as if they might be three or four days old.

Queens generally begin to crawl about the entrance of the hive, possibly looking out now and then when 5 or 6 days old, The next day, supposing, of course, it is fine weather, they will generally go out and try their wings a little. These flights are usually taken in the warmest part of the afternoon. There is no prettier or more interesting sight to the apiarist than the first flight of a queen. She runs this way and that, somewhat as does a young bee, only apparently much more excited at the prospect of soaring aloft in the soft summer air. Finally she tremblingly spreads those silky wings, and with a graceful movement that can not be equaled anywhere in the whole scope of animated nature, she swings from her feet, while her long body sways pendulously as she hovers about the entrance of the hive. A worker bee hovers also about the entrance and carefully observes its location when trying its wings for the first time; but she, seeming to feel instinctively that she is of more value to the colony than many, many workers, with the most scrupulous exactness notes every minute point and feature of the exterior of her abode, often alighting and taking wing again and again, to make sure she knows all about it.

Soon she ventures to circle a little way from home, always verging back soon, but being gone longer each time. She sometimes goes back into the hive satisfied, without going out of sight at all; but in this case she will be sure to take a longer flight next day or a half-hour later in the same day. During these seasons she seems to forget all about surrounding things, and, instead of being frightened as usual at opening the hive, she will pay no attention; but if the comb she is on is lifted up she will take her flight from that as well as from anywhere else. They have been caught in the hand at such times, without their being frightened; and as soon as they were allowed to go, they were off as if nothing had happened.

After the queen is satisfied that she will know the place she ventures out boldly; and from the fact of her circling right up in the air, it was once supposed that fertilization took place above the ken of human eyesight. This has been shown to be a mistake. (See Drones.)

After a successful flight she returns with the organs of the drone remaining attached to her body. (See Drones.) This is a white substance, and is frequently so large as to be plainly seen while she is on the wing. A queen is usually gone half an hour, but she will sometimes return fertilized after an absence of not more than 10 or 15 minutes, and there have been reported instances where she has been gone not more than three minutes. This accomplished, she goes quietly into the hive. The bees are much inclined to chase after her, and they sometimes pull at the protruding substance as if they would drag it away. That they do so is pretty well proved.

Does the Queen Meet the Drone More Than Once

Until recently it was generally believed that the queen met the drone only once,

notwithstanding the fact that Francis Huber, in his book, "New Observations," published in 1814, now translated by Dadant made the statement that queens might or might not take more than one wedding-flight before beginning to lay. But this seems to have been overlooked until 1904 when considerable proof was adduced to show that the same queen before laying (not after) may not only take several wedding-flights, but come back on different occasions with sure evidence of having met a drone.

While it seems to be pretty well proved that the queen may take more than one marriage-flight prior to her laying, it is very much doubted whether she ever takes a second flight to meet the drone after laying. It is true that some facts seem to point that way; but when the great number of spermatozoa that she receives on her wedding flight is considered it hardly seems likely that a flight is taken later.

For further particulars on this subject of mating, see Drones, page 231.

When the Queen Begins to Lay After Mating

The third or fourth day after a successful mating one will, as a general rule, find the queen depositing eggs. The average age at which queens begin laying is about nine days. Between impregnation and the time the first egg is laid a remarkable change takes place.

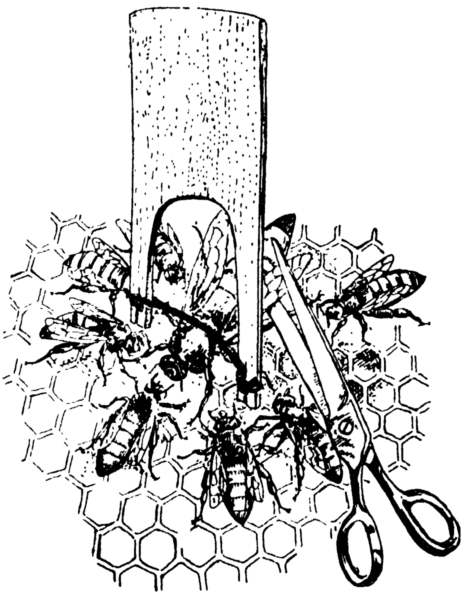
After the queen has been out and fertilized, her appearance is much the same as before. She runs and hides when the hive is opened, and looks so small and insignificant that one would not think of calling her a fertile queen. A few hours before the first egg is laid, however, her body increases remarkably in size, and, if an Italian, becomes lighter in color, and, instead of running about as before, she walks slowly and sedately. She seems to have given up all her youthful freaks, and comes down to the sober business of life in supplying the cells with eggs.

How Old a Queen May be and Still Become Fertilized

As before stated, queens usually begin to lay when 8 or 10 days old, on the average; but during a spell of bad weather, or when drones are scarce, they may fail to lay until three weeks old. The longest period we have ever known to elapse between the birth of a queen and her laying worker-eggs is about 25 days. All queens that do not lay at the age of 20 days should be destroyed, unless it is out of season. Many times queens will not lay in the fall at all unless a flow of honey is produced either by natural or artificial means. Queens introduced in the fall often will not lay until the ensuing spring, unless the colony is fed regularly every day for a week or ten days. Likewise young queens that are fertilized late in the season will often show no indications of being fertilized until the following spring.

Shall Queens' Wings be Clipped?

Most of the honey-producers practice what is known as clipping; that is, both wings on one side are cropped off, leaving merely the stumps of what were once



Holding the queen on the comb with a wooden fork and rubber band for the purpose of clipping.

wings. The object, of course, is to prevent swarms from going off by making it impossible for the queen to follow. (See Bee Behavior, also Swarming.)

There are very few who believe or profess to believe that clipping is injurious to the queen. The fact that queens after being clipped seem to do good service for two or three years, and sometimes four, and the further fact that such queens do as well as those not clipped, would seem to show that no detrimental results follow.

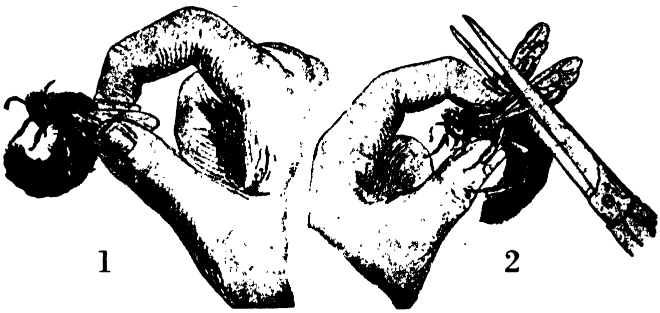
How to Clip a Queen's Wings

There are several ways of accomplishing this. One plan is to grasp the queen by the wings with the right hand, in the usual manner. With the thumb and forefinger of left hand, take hold of her waist, or thorax. In this way she can be held very securely and safely, leaving her legs as well as her wings entirely free. With a pair of slender-pointed embroidery scissors (or any kind of scissors if these are not obtainable) clip off both wings on one side only, being careful not to cut too close. This accomplished, drop her gently between two frames of brood; but in no case let her fall more than an inch; for a queen during the height of the egg-laying season is liable to be injured if handled roughly. Some prefer, after picking up the queen, to grasp her by the legs; but this is liable to pull one or more legs off unless done just right, and therefore the first-mentioned plan is recommended.

Before any one of these plans is attempted, if one has had no experience he should first practice on drones. If these are not to be found, worker bees should be picked up by the wings until one becomes reasonably expert; but a worker should not be put between the thumb and finger of the other hand, as one will run a good chance of being stung. For this part of the work drones should be procured. Then, when one can do both operations well, he can try a queen. Even then the attempt should be made on one of not much value, as it is a nice piece of work to do it well.

Sometimes in an outyard, when a pair of scissors is not to be had, a sharp blade of a pocketknife can be used. This is passed under the wing in such a way as to cause it to bear directly upon the edge of the blade. The thumb is now pressed down upon the wing over the blade, and then drawn back and forth seesaw fashion, perhaps two or three times. If the knife is sharp, the wing will be severed with two or three strokes. If it is dull, the queen should be laid on her back, still holding her between the thumb and finger of the left hand so that her wing will bear directly upon a hive-cover or any other piece of board or wood. The edge of the knife should be brought to bear upon the wing, when a slight pressure will cause the blade to pass through it.

During these operations care should be taken to handle a queen only by the wings or the thorax. This way avoids all danger of hurting her. One should be careful not to press the abdomen of any queen.

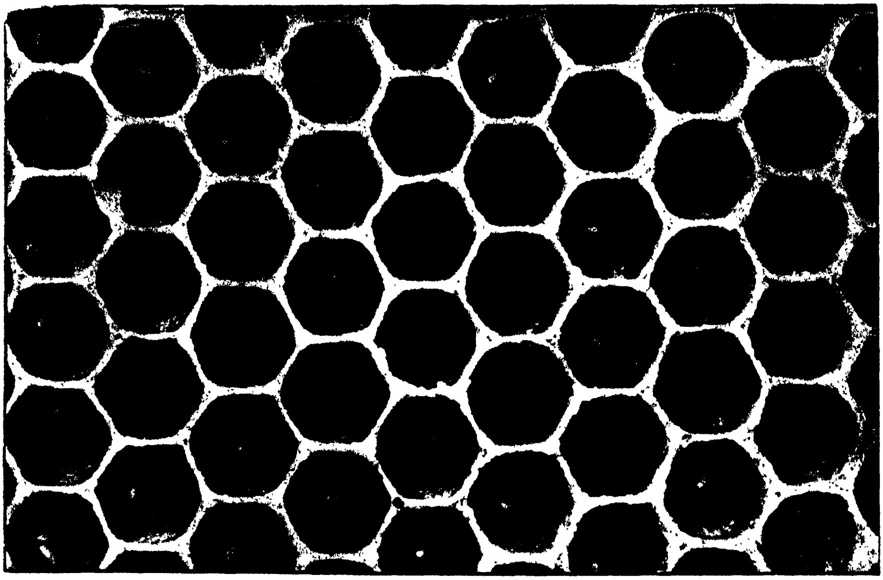


How to pick up a queen and clip her.

How Queens Lay Two Kinds of Eggs

That queens lay two kinds of eggs no one now is inclined to dispute, since the experiments with the microscope have decided the matter so clearly, as stated under Drones. Suppose a young queen goes out to meet the drones so late in the fall or so early in the spring that there are none; what is the consequence? Sometimes she will never lay at all; but frequently she commences to lay when three or four weeks old, and her eggs produce only drones. In fact, she can produce no other eggs, having never been fertilized. How shall such queens be distinguished from fertile ones?

No one can decide positively concerning them, until their brood is ready to seal up; then one can know by the round, raised cappings of the brood, like bullets laid on a board, as explained under Drones. (See Brood, large illustration of worker and drone brood, page 111.) One can give a pretty good guess by noticing the way in which the queen lays the eggs; if they are few and scattering,



How the eggs are deposited in the comb. See Brood and Brood-rearing.

and sometimes or often in drone-cells, coupled with the fact that she did not commence laying until two weeks or more old, she should be replaced. A young queen, if properly fertilized, never, or very rarely, lays an egg in a drone-cell; and when she commences to lay, she fills cell after cell in regular order, as men plant hills of corn; her work also has a neat and finished appearance that says at once to the expert, "She is all right." See cut above.

In rare cases a young queen begins with all, or nearly all, drone eggs, but, after a while, lays entirely worker eggs as regularly as one could wish. It is not known why this is; perhaps she has not yet got used to the "machinery." Again, any queen is liable any day of her life to begin laying drone eggs altogether or in part. A nice young laying queen, taken from a hive and shipped to a distance, may prove to be a drone-layer shortly after or immediately after she is received. Such things are not very common, but they do occur. Out of three or four hundred colonies one may find one drone-layer, on an average, each spring. During the summer, perhaps one more will be found. It is probable that the queen was not fertilized sufficiently, and that the supply of spermatozoa gave out while she was in full vigor, thus reducing her to the condition of a virgin queen. Microscopic examination has shown an entire absence of spermatozoa in at least one or two instances where queens of this kind were killed and dissected. Similar experiments given by Dzierzon show that the spermatozoa may be injured beyond recovery by chilling the queen, and yet the queen herself be resuscitated. Hardship and being shipped long distances may produce the same result.

Queens not only turn suddenly to drone-layers, but they sometimes produce about an equal number of each kind of eggs. In all these cases where the queen lays drone eggs when she evidently intended to lay worker eggs, they are in worker-cells; at the same time the number of eggs laid usually rapidly decreases. The bees, as well as the queen, evidently begin to think that something is wrong; queen-cells are soon started, and after the young queen emerges she becomes fertile and begins to help her mother. (See Supersedure of Queens.)

Queen breeders often desire to get drones out of season for late matings but without much success. There seems to be a kind of understanding that eggs shall be laid in drone-cells about the last of March; and drones are found, therefore, some time in April, ready for the first queens that may, by any accident, make

their appearance. In the same way nature concludes no drones will be needed in the fall.

Loss of Queen

It is a very important matter to be able to know at once when a queen is lost. During the months of May and June in the states east of the Mississippi and north of the Ohio the loss of a queen from the hive a single day will make quite a marked difference in the honey crop. If it be assumed that the number of eggs a queen can lay in a day is 1500 by taking her away a single day there might be just that number of bees short during a yield of honey. (See page 144.) To put it very moderately, a quart of bees might be taken out of the hive by simply caging the queen for a single day. Beginners should remember this, for their untimely, or, rather, inconsiderate tinkering, just before the flow of honey comes, often cuts short their income to a very considerable degree. Whatever is done, it is very important not to drop the queens off the combs when they are handled at this time of the year, nor should one needlessly interrupt the queen in her work by changing the combs about so as to expose the brood or upset the little household matters of the bees.

With a little practice one will be able to detect a queenless hive simply by the way the bees behave themselves in the hive and on the outside. When they stand around on the alighting-board in a listless sort of way, with no bees going in with pollen, when other colonies are thus engaged, it is well to open the hive and take a look at them. (See Diagnosing Colonies.) If eggs and worker-brood are found one may be sure a queen is there; but if not, proceed at once to see if there is not a queen of some kind in the hive, that does not lay. If one is not found they should be given a frame of eggs to see if they will build queen-cells. Incipient ones should be found in about twenty-four hours if the bees have been some little time queenless. If these are found a queen should be given. If no queen is to be had, they may be allowed to raise one, if the colony has bees enough. If it has not, they should be united with some other stock.

The Cry of Distress from a Queenless Colony

A queenless colony will reveal its condition, if not of long standing, by the behavior of the bees in the hive. They will set up a peculiar cry—that is to say, all through the hive they will be buzzing as if in distress, and they surely are, because they have no queen. As soon as a hive of this kind is opened they will begin this cry of distress. Sometimes only a part of the bees will be involved, and at other times apparently every bee in the colony. This buzzing of the wings is so marked that the practiced beekeeper recognizes it as an indication that a colony may be queenless; and if he finds no eggs nor young brood at a time of the year when both should be present, he is quite sure that the hive has no queen. If he finds queen-cells, all doubt will be removed. Sometimes a colony that is not queenless will set up a buzzing as if they were without a mother. It is then evident that the show of distress is not because they have no queen but because of the disturbance. Too much smoke, for example, with most colonies and a little smoke with some colonies will cause them to make this sign of distress. It must, therefore, be regarded as not an infallible sign of queenlessness. Colonies that have been queenless for a long time will no longer indicate their condition in this manner.

Odor of a Laying Queen

After bees have been some time queenless they usually become very eager for a queen, if no laying workers make their appearance (see Laying Workers), and in no way can this eager behavior be described so well as to describe another way of testing a colony that is thought to be queenless. Take a cage or box containing a laying queen and hold either the cage or simply the cover of it over the bees, or hold it in such a way as to let one corner touch the frames. If queenless, the first bees that catch the scent of the piece of wood on which the queen has been will begin to move their wings in token of rejoicing, and soon nearly the whole colony will be hanging to the cage or cover. When they behave in this manner there will seldom be any trouble in letting the queen out at once. Such cases are generally where a colony is found without brood in the spring. (See page 65.)

There is something very peculiar about the scent of a laying queen. After having had a queen on the fingers, bees will often follow and gather about the hand.

They will often hover for hours about the spot where the queen has alighted for even an instant, and sometimes for a day or two afterward. Where clipped queens get down into the grass or weeds or crawl sometimes a considerable distance from the hive, they may often be found by watching the bees that are crawling about along the path she has taken. When cages containing queens are being carried away bees will often come and alight on the cage, making that peculiar shaking of the wings which indicates their joy on finding the queen.

Queens' Stings

There is something rather strange in the fact that a queen very rarely uses her sting, even under the greatest provocation possible, unless it is toward a rival queen. In fact, she may be pinched or pulled limb from limb, without even showing any symptoms of protruding the sting at all; yet as soon as she is put in a cage or under a tumbler with another queen the fatal sting is almost sure to be used at once. There seems to be a most wise provision in this; for if the queen used her sting on every provocation as does the worker, the prosperity of the colony would be almost constantly endangered.

It was just stated that a queen very rarely uses her sting; but it is the exception that proves the rule. The following will explain.

> One very young virgin queen that stung me was well developed and later proved to be a good queen for business. The other virgin, also very young, that stung me was from a good-looking cell, and I suppose was all right. As it was so much easier to crush her than to endure her continued stinging till I could get her out of my clothing, she was killed without knowing positively what kind of a queen she would have proven herself to be.
>
> Ceres, Calif. W. A. H. Gilstrap.

Caution in Regard to Deciding a Stock to be Queenless

As a rule it may be said that absence of brood or eggs is a pretty sure indication of queenlessness; but it should be borne in mind that, as a rule, all colonies in the eastern and northern states are without eggs and brood in the fall and early winter months, or, in fact, any time when there is a considerable dearth of pasturage. At such seasons beginners are more apt to think their colonies are queenless because the queens are much smaller then than when they are laying profusely, and therefore are not as easily found. In the North queens often cease laying during all of the winter months. They will not lay much while their colonies are in the cellar except sometimes the last month in the cellar. In California and the semi-tropical states of the South queens may lay every month of the year.

For further particulars regarding queens, see Drones, Queen-rearing and Bee Behavior.

QUEENS, HOW TO FIND.—See Manipulation of Colonies, subhead, How to Manipulate Hoffman Frames; Diagnosing Colonies; and Introducing, subhead, How to Find Black Queens.

QUEENS, SUPERSEDURE OF.—Technically speaking, supersedure is an act of the bees in replacing the old queen with a new or a young one. Requeening is exactly the same thing, but it is the act of the beekeeper. (See Requeening and Introducing.)

Queens seldom live more than three or four years when the colony is left to itself. After one or two years of heavy egg laying, the average queen will not, as a rule, be of much value to the colony. If she does not die a natural death the bees will probably supersede her, and if they do not, the apiarist himself should replace her. Most of the best bee men requeen every year in late summer or early fall. (See Requeening.)

While some queens of an exceptional value are good for two or three years, experience shows that the average queen should be replaced in one year. As a rule, the average colony will supersede its own queen in two years without any attention on the part of its owner. The process is a perfectly natural one and goes on in the best regulated yards year after year. Experience shows, however, that the up-to-date beekeeper better requeen, as explained after the first year, before the bees supersede their queen. (See Requeening.)

Some queens in their early larval period have not been properly fed. Perhaps the cells in which they were reared were chilled or overheated. The result is they are weaklings at the very start of their career. They are deficient in egg laying, of which fact her subjects very quickly take note. They start building supersedure cells just as they do in the case of old queens that have given a good record, but are now worn out. The bees seem to know that their very existence depends

on a good queen. So when their mother fails from any cause, they will proceed to raise another queen.

It very often occurs that mother and daughter will be found laying side by side on the same comb; but the condition does not last long until the old queen will be missing. It is not known whether she dies a natural death, whether the daughter disposes of her, or whether the bees help to bump her off.

Supersedure in Package Bees

Complaint has sometimes been made that the queens of package bees are superseded. (See Package Bees.) Some seasons this supersedure is more noticeable than at others. When the weather is unfavorable at the time the package bees are installed, particularly if no honey is coming in, the bees are apparently dissatisfied, and blame their troubles on the queen and kill her.

At other times the supersedure is due to improper raising of the queen. Unless she is well fed in the larval state her egg-laying will be deficient or sporadic. Her bees will very soon proceed to raise supersedure cells from her eggs or larvae.

Again, supersedure, as pointed out by David Running, is due to too much tinkering with the hives containing the packages. Very often experienced apiarists have noticed that the bees of a strong colony will suddenly ball a good queen shortly after the hive is opened and unless their owner rescues her from her plight, she will be superseded, and for no other reason apparently than that the bees were disturbed when they were in no mood to be tinkered with.

When honey is coming in, and the weather is warm, bees are not inclined to supersede a good queen. At such times they will readily accept a queen introduced to them. But when the flow stops or there is a continual dearth of nectar, the colony should be left alone unless it is to take off the honey. (See Balling of Queens under Bee Behavior; also Balling of Queens under Introducing.)

R

RABBITBRUSH (*Chrysothamnus*).— See "Honey Plants of North America."

RACES OF BEES. — Among social bees or Apidae, are three general groups: stingless bees, Melipona, mentioned under Bees, Stingless; bumblebees, Bombus, mentioned under Bumblebees, and honeybees, Apis.

Under the general genus Apis are included *Apis dorsata,* or *zonata; Apis indica,* of India; *Apis florea,* the tiny East Indian bee; and finally the honeybee, *Apis mellifica,* the species under which the commercial races are classed. Under this general species are a large number of varieties or races, which in general characteristics and size are the same; but they differ in color-marking and general behavior. While the classification may not be scientific, they may be divided into two general groups, the black or brown bees and the yellow bees. The former seem to have the wider distribution, taking in nearly all of central Europe, Great Britain, northern Africa, and Madagascar and America. The black or brown bees all look much alike.

The second group, or yellow bees, comprises, first in importance, the Italians, found originally in north-central Italy and then imported to America and to other countries; the Cyprian bees from the island of Cypress, possibly the mother race of all the yellow bees; the Syrian bees in Syria; the Palestinians or Holy Land bees, in Palestine; the Egyptian bees in southern Palestine and in Egypt; and last, but not least, the Saharan bees, found in the great Saharan Desert and said to be the gentlest bees in the world. The yellow bees, like the blacks, look alike.

The Black or Brown Bees

Of these there seem to be two common types, the Dutch or Heather bees, found originally in Holland and imported to America, and the black or brown bees, found all over central Europe and in

Great Britain. The black bees of America are evidently of Dutch and not of German origin, as has been so frequently stated in all bee literature. The difference in general behavior of the two types is so marked that they might be called two separate races. The real German or English bee, found all over central Europe and particularly in southern France and in Great Britain, is regarded by some as equal if not superior to Italian bees found in northern Italy. The real Dutch bees found in America are not favored by practical beekeepers in America or in Europe. While it was supposed at one time that there were two types of black bees in the United States the author believes, after very extensive travel through the southern states, where the black bees predominate, that there is only one type, those of Dutch origin. The native bees of Virginia, North and South Carolina, Georgia, Alabama, and Louisiana, while varying slightly in color from jet black to brown, have the same general characteristics. They are all more inclined to rob than pure Italians, and are not as good workers, but are equal when nectar is abundant, or when there is dark honey, like that from buckwheat. They are much more nervous, and when a hive of them is opened they run like a flock of sheep from one corner of the hive to the other, boiling over in confusion, hanging in clusters from one corner of the frame as it is held up, and finally falling in bunches to the ground, where they continue a wild scramble in every direction. It is because of this wild scramble that it is very difficult to find the queen. (See close of Introduction and Manipulation of Colonies.)

The Dutch or American bees have a disagreeable fashion of following one about the apiary during robbing time. Their habit of poising on the wing before one's eyes is extremely annoying, and those same bees will keep it up for a day at a time unless they are destroyed. They are more inclined to swarm than Italians, and among the old-fashioned beekeepers of the southeastern states they swarm so excessively that in many instances nothing but the first or prime swarms survive, the rest dying through winter.

They have two or three redeeming features that seem to belong to the more desirable German or brown bees of central Europe and Great Britain; they cap their honey whiter than the Italians or yellow bees; they are more readily shaken off the combs during extracting time; and they are more easily moved short distances than Italians. (See Moving Bees.)

In general disposition they are not crosser than Italians; but on account of the wild scramble in the hive and on the ground they sometimes get under clothing, and, of course, they sting worse than Italians.

German or Brown Bees of Central Europe and Great Britain

While these bees are similar in general appearance to the Dutch bees just described, they are not quite so black in color, and are generally called brown bees; but the average person would not be able to distinguish one from the other. This race, with more or less modification, according to environment, says Baldensperger, is found all over central and northwestern Russia, Sweden, Norway, the British Isles, the Netherlands, Germany, Austria, Switzerland, France, Spain, and Portugal. The black bands, says this same authority, are bordered with yellowish fuzz on the segments of the abdomen, which gives them their brownish appearance. In southern France, where they are the almost universal bees, they are easily subdued by smoke, do not run or scramble over the frames as do the Dutch bees in America, are hardy and disease-resistant. While the black bees of America, unlike Italians, fall an easy prey to European foulbrood the real French bees, says Mr. Baldensperger, are just as resistant to this disease as American Italians.

Apparently Cowan, Simmins, and some other leading authorities in Great Britain prefer the Italian to the English brown bee; but the fact that the Italians have not made the headway in Great Britain that they have in America would seem to indicate that the brown bee of these countries is nearly equal to the Italians.

In making comparisons between Italian and black bees it is well to bear in mind which strain of black bees is under consideration.

Why Brown Bees Should Not be Exported to Other Countries

On account of the general prevalence of Isle of Wight or Acarine disease of Great Britain and parts of Europe (see Diseases of Bees), it would be unwise to import any of the brown bees into Amer-

ica. No one claims that brown bees of Great Britain or Europe are superior to the American Italian. The danger of scattering this terrible scourge, by importing the brown bees to America is such that the American government will probably never allow such bees to come into this country. (See page 228.)

Other Black Bees

There are several other excellent races of black bees, such as Carniolans, Caucasians, and Banats. All of these races are considered to be superior to either the Dutch or the German brown bee. They have been introduced into several foreign countries and into America. In a general way, it may be said that they are gentler than either of the black races that are so common, equal to them in honey production, and in many respects compare favorably with the Italians; but they look so much like the ordinary black bees that few can distinguish them from such bees.

Carniolans

Frank Benton made shipments in the early 80's of this race. At the same time Dadants imported 10 Carniolan queens which were sent by Fiorini, who made a special trip from Italy to Carniola.

In speaking of the Carniolan bee, Francis Jager says: "The large silver grey bee is found northeast of the mountain divide of the Alps in former Austria. They extend as far north as the Danube River where they begin to assume a brownish color which turns into a black toward Germany. They extend east into the Banat plains of Hungary and south into the Balkans as far as the Bistrica River. They are found in their purest type in Carniola but on the Adriatic coast a mixture of yellow blood is found. The segments of the abdomen are black, banded by a grayish ring covered with a whitish fuzz. It is by this fuzz that Carniolans can be distinguished from brown bees."

Some consider them much gentler than Italians, but the author has tested them for a number of years and finds them about the same as the average Italian. They are gentler than the brown bee of France. Like them, they do not run on the combs, but are perfectly quiet. They are excellent breeders, and in some localities in the United States are considered to be superior to Italians because they will rear brood when Italians will not.

Carniolans have one bad trait — they are excessive swarmers. They would not, for this reason, be suitable for American out-apiaries.

They have one distinguishing feature that makes them very desirable — they deposit little or no propolis. Their combs are white and clean, and for the production of comb honey they should be ideal, except for their swarming propensities.

Caucasians

This race closely resembles the common black bees of Europe. The resemblance is so close that even experts have not been able to distinguish the difference, and it would therefore be possible for unscrupulous queen-breeders to sell the inferior race for the better one.

While it seems to be agreed that Carniolans deposit the least propolis of any race, Caucasians, next to Tellurians or Tunicians, as they are sometimes called, have the reputation of using the most. This trait, while objectionable in the production of comb honey, would not be serious when running for extracted honey.

Like Carniolans, some strains of Caucasians are inclined to swarm excessively. But the strongest claim in favor of this race is that they are the gentlest bees in the world. (See cut, page 88.) With some strains the claim seems to be justified. With other strains of the same race a contrary view has been held. Dr. E. F. Phillips, who visited the Caucasian regions, explains in an article in Gleanings in Bee Culture, page 591, for the year 1933, how this divergence of opinion may occur. He finds that the bees in the plains are very cross, while those up in the mountains are very gentle. It is important that the American importers of Caucasians should specify and demand the strain that comes from the mountains.

The claim has been made that Caucasians have slightly longer tongue reach than Italians. (See Tongue Measurements of Honeybees.)

During 1932, 1933 and 1934 considerable favorable comment has been manifested toward the gentle strains of Caucasians, that are said to be very hardy, good workers, and not inclined to excessive swarming.

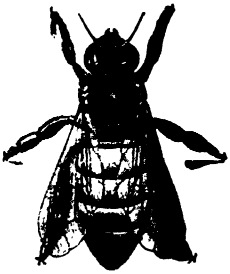
It is apparent that Caucasians are not as fixed a race as Italians, and one would do well not to get too many of these bees until they have been further tested in this country.

Banat Bees

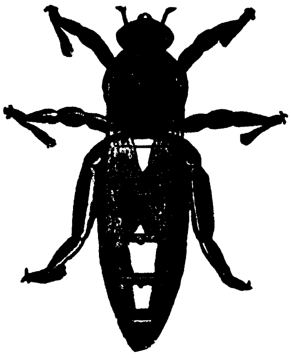
These are named after a district of Hungary, from which they were imported. They much resemble the Caucasians, and may be a strain of Carniolans, it is said. Those who have tried them say they are very gentle, but because they are so much like the ordinary brown or black bees of Europe it would be almost impossible to distinguish them.

North African Black Bees

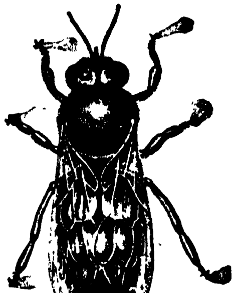
These bees have been given various names. The most commonly accepted, perhaps, is Tunisians, or Punics, but Baldensperger does not think that these names are correct, because they are found all over northern Africa. He recommends the name Tellurians or Tellians. They have been tested to some extent in the United States, but so far have not been able to establish any claim in their favor that would entitle them to consideration by American beekeepers. They are cross and are so inclined to smear everything with red bee-glue that they are entirely unsuited for the production of



Drone.



Queen.



Worker.

comb honey. They are, in fact, an inferior race in almost every respect, and should never be imported into any new territory or country.

Madagascar Bee

This bee is found on the island of Madagascar and it has been bred there probably for thousands of years. It is a pure race. It is found not only in Madagascar but on some of the islands adjacent, and later no doubt, was introduced on the mainland of Africa itself. It is probably the blackest bee of any of the races because the bodies are scantily covered with a brownish fuzz. Not much is known concerning the general characteristics of these bees, but they are not thought to be worthy of introduction into other countries.

West African Bees

This is a dark bee found on the western coast of Africa, resembling both the heather bee and the Madagascar bee, and like the latter, is an inferior race.

YELLOW RACES OF BEES

We will now turn our attention to the yellow races of bees, of which the Italians are the best known but probably not the mother race. In this list we will place first of all Italians, Cyprians, Syrians, Palestinian, or Holy Land bees, Egyptians, and last but not least, Saharans from the desert of Sahara of north central Africa.

Since the Italian bee was introduced into this country before other races and since it has become so widespread and since we have developed an American race, it is well to look into the origin and history of this race. Baldensperger says the origin or introduction of this bee or its hybridization is not definitely known, but a hypothesis may be formed. Aristotle and Virgil both had a knowledge of dark and bright bees. The Greeks were well versed in beekeeping as early as 750 B. C., with bars in their hives and regulations in regard to overstocking. The bees were taken whereever the primitive sailors went, and where this stay was to be more than one year an apiary was established. The Greeks probably brought the yellow Cyprian race with them. These spread in the spring following their arrival and crossed with the dark race then existing on the Italian peninsula.

As the Roman civilization advanced

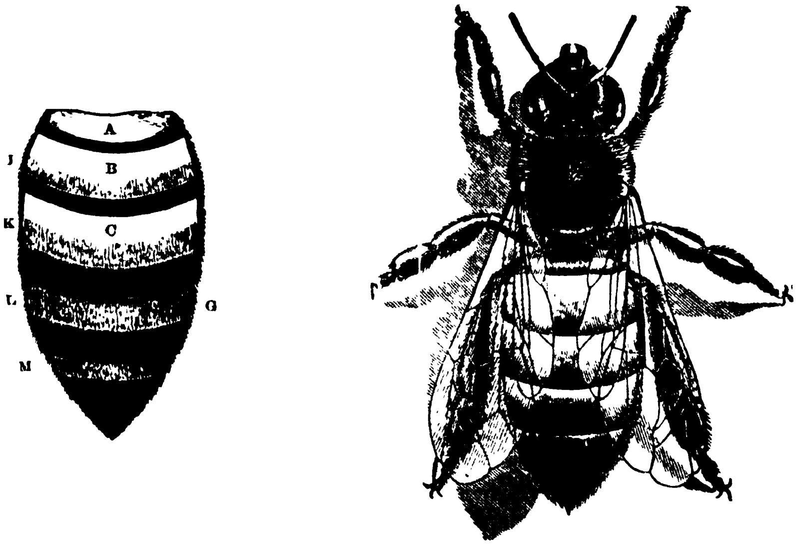
north so did the yellow bees, absorbing the blacks and forming the modern Italian race. This race does not yet show a constancy in color; there are dark Italians and light Italians. Drones of this race sometimes are bright yellow and again may show but a narrow ring on the first segments.

In 1843 a Swiss apiarist brought a few colonies from Italy. It was not until 1853 that Dzierzon introduced bees from Italy to his home in Silesia, Germany. It was with these Italians that he was able to prove his theory of parthenogenesis. The Italians were first brought to France by Hamet in 1856, but have not made such rapid progress as they have in America. The first importation to America was made through Dzierzon in 1855, and the first direct shipment was in 1860 to S. B. Parsons, Flushing, New York; M. Mahan of Philadelphia also received queens this year. In 1863 importations were made by Langstroth from Germany.

The Italian Bee Company was organized at Des Moines in 1865 with Mrs. Ellen Tupper and Mrs. Annie Savery as partners. The object of this company as stated by them was "to make the Italian race of bees easily available to the beekeepers of Iowa." Records are not available to show how successful this company was in obtaining its objective or how long it persisted.

In 1872 Chas. Dadant contracted with Mrs. Tupper to make a trip to Italy to prepare bees for importation to America. The Dadants had received shipments from Italy in 1868 following Adam Grimes, of Wisconsin, who went to his home in Germany and to Italy to send bees back to his own yard in 1867.

The Italians are more generally used in this country than any other race of bees. Commercially they are the most important race in the world. They are gentle, hardy, good workers, quiet on the combs, beautiful to look at, and not inclined to swarm. Most of the Italians raised in this country have three yellow segments or bands bordered with black. A, B, and C represent the yellow; the shaded portions the fuzz rings. Some extra yellow bees will have four and in extreme cases five bands. The native strains direct from Italy, or what are called imported Italians, will show only two yellow bands as at B an C, with the third one sometimes showing next to the thorax, as at A, in the cut. The American Italians show more and brighter yellow than do the bees direct from Italy.



Markings of Italians.

The yellow of the imported bees is on a leather order—a muddy or dark yellow.

The queens of the race vary in the amount of yellow. In rare cases the abdomen will be all yellow. In most cases the upper part of the body will be yellow while the lower part or tip will be black. In other cases, the queens will show alternately yellow and black bands.

The drones, like the workers, may be striped, but are usually darker, showing sometimes one and two bands of yellow. Except for the Cyprians, the Italians are admittedly the most beautiful bees in the world, and for all around good qualities and general fixity of character, they are the equal, if not the superior, of any race. In this connection note what Phillips has to say on page 624.

As the swarming problem, next to that of wintering, is one of the most difficult to solve, it is apparent that a race of bees that swarms the least, other things being equal, should be preferred. In this respect the Italians have the lead. They will follow regular laid-down rules in respect to swarming, and seldom depart from them. The black bees of the United States, certainly the Carniolans and some strains of Caucasians, will swarm in season and out of season, breaking all rules, making it almost impossible for the ordinary honey producer to know how to control them. Unless he controls his swarms his crop of honey will be very materially diminished. With Italians it is possible to hold the swarming propensity in bounds.

As regards wintering, the Italians are equal to any race of bees in the world. Some have thought that the black bees were more hardy, but after many years of observations, comparing Carniolans and Caucasians with Italians, the Italian bees have demonstrated their ability to winter as well as any bees that have ever been tested in this country.

As to resistance to European foulbrood, it is a well-established fact now that the American Italians, and probably the Italians of Italy, are much more immune than the American black bees. Baldensperger is of the opinion that the brown bee of southern France is equally resistant.

When it comes to the moth worm, the Italian bees will not tolerate them in the hive, as do the American blacks. Many years ago A. I. Root, to test out the ability of Italians to clean out the moth worm in a hive of black bees, frequently introduced into them young Italian queens. He found that, as soon as the young Italians began to emerge, they made short work of the moth worms, and as he described it, "led the worms out of the hives by the ears." Unless a colony is very strong, the black bees will allow the moth worm to overcome them.

Some have thought that Italians are more inclined to rob than other races of bees. This may be true. If so, this very quality—to get sweet under any and all conditions — is the quality that makes bees good honey-gatherers. The best Italian queen that A. I. Root ever had, one whose bees would gather honey when other bees would gather none, and had the record for the largest yields per colony in the apiary, produced the worst robbers he ever had. After all, robbing is not a serious problem in a modern apiary where buildings and hives are made bee-tight, and where the beekeepers takes ordinary precaution.

So much for the Italians in America. There are some authorities in Great Britain, notably Simmins and Cowan, that believe that Italian bees are superior to the English brown bee. It is also a noticeable fact that the Italian bees are working their way up into central Europe, but whether they will ever displace the common brown bees that have done so well in those countries is doubtful. If central Europe had had the inferior Dutch bees, such as America has had, there is no question that Italians would have been the universal race—at least among progressive beekeepers.

EASTERN RACES OF BEES

These comprise three separate races, namely, Cyprian, from the island of Cyprus; Syrians, from Syria, north of Palestine; Palestinians, or Holy Land bees, from the Holy Land itself. These three races very greatly resemble Italians in color but are very different from Italians in general characteristics, especially in their behavior. They were first introduced into this country by D. A. Jones, of Beeton, Ontario, Canada, and by Frank Benton in 1882. Mr. Jones and Mr. Benton spent some little time investigating these races with the result that they believed that they were worthy of introduction into this country. Large numbers of queens were subsequently sent by Mr. Benton to all parts of the United States and Canada.

Cyprians

The Cyprians, says Mr. Baldensperger, resemble Italians, but on close examination the expert beekeeper will note that the Italians are muddy yellow where the Cyprians are a dark orange. The orange-colored bands, usually three in number are wider, and may also extend to the fourth

abdominal ring. Every one of the six rings is bordered with black. The fuzz bands on the Cyprians are of a brownish color, and at the base of the thorax the Cyprians show a yellow shield called the crescent, by which they can easily be distinguished from other races. While this shield is seen in other bees, as in the Italian it is not so marked as to attract attention as in the Cyprians. The under side of the Cyprians is a beautiful orange, while the under side of Italians is a muddy black-brownish color.

In all probability the Cyprians are the mother race, not only of Syrians and Palestinians, but of Italians. For countless ages they have developed as a pure type on an island, but as they are energetic and beautiful they were carried to the main land, some probably to Italy, others to Syria and the Holy Land, with the result that they have developed crosses with the blacker races of the north. Unless it be the Egyptians, the Cyprians are the crossest bees known, and were it not for that fact they would probably have been very generally introduced not only in the United States but in all Europe. As there is only a scant supply of nectar-bearing plants, the Cyprians are very energetic, and when introduced into this country they have been credited with large yields of honey.

The author tested these bees for a series of years in this country and agrees with the general verdict that they are so "awfully vicious" that, in spite of all their good qualities it is hardly worth while to propagate them. They must be handled with a great deal of care, and even smoke at certain times will not subdue them. In fact, it seems to irritate them all the more.

On one occasion the author had one colony of them that became so infuriated that every bee left the hive and went on a general rampage of stinging. It certainly would not be safe to have colonies of them near a public highway. Those who have been accustomed to them have been able to handle them, but great care must be exercised.

The Syrians

The Syrians, found in Syria, in the region of Lebanon, are an excellent race of bees, resembling both Italians and Cyprians. They are very prolific and good workers. The color markings consist of pale lines on the first three segments of the abdomen. The fuzz covering the thorax and the wing edges is yellowish. The crescent, although distinctly visible, is not so pronounced as in the Cyprians.

On account of their isolation south of the Taurus Mountain ranges they are almost a fixed race. Their darker color is doubtless due to the bees that have come across the mountains, making them slightly darker than the Cyprians. Like the Cyprian bees, they are nervous, though not quite so vicious; but, nevertheless, a large amount of smoke must be judiciously used.

Palestinian Bees

The Palestinians, or Holy Land bees, found in the Holy Land, are slightly different from the Syrians, but much like them in general characteristics. They are more nervous and almost as cross as Cyprians. The first three segments of the abdomen are citron-colored, bordered with black. The fuzz rings are grayish, and when young they seem lighter. The crescent at the base of the thorax is also of a dull gray color.

The Palestinian bees seem to be slightly smaller. The queens are long and slender, and prolific layers.

In the matter of rearing queen-cells the eastern races, especially Palestinians, far excel any other races known. In the early eighties the author raised a good many queens from cells reared in colonies containing Holy Land bees. The cells were not only very numerous, but the queens, when they emerged from the cells, were large and strong. On one occasion the author saw a young queen take wing and fly within two or three minutes after she emerged from her cell.

This very virtue of being good breeders and cell-builders, so far from being such, is a liability. The trouble with these eastern races is that they raise brood in season and out of season. They exhaust their vitality and use up all the stores so that they are not in condition to go through the rigors of winter in the United States. They are better adapted for warm climates, where the honey season is continuous. Italian bees, on the other hand, are not only very gentle, comparatively speaking, but will stop brood-rearing after the main honey flow is over. This not only saves stores, but it saves the life of the queen and the colony itself.

Another bad trait is that the the eastern races are inclined to develop laying workers. This is especially true of the bees of Palestine. Both the Palestinian and Egyptian bees, if left queenless for a short time, will have laying workers in short order.

The fact that the eastern races have not been adopted either in America or in Europe to any great extent is somewhat significant. Their vicious temperament and their tendency to breed in and out of season would not make them suitable for commercial honey production, certainly not for the northern states of this country.

Albinos

These are light-colored bees; but about the most conspicuous marking is that the fuzz rings are light gray or almost white, hence the name Albino. They may be (and probably are) "sports" from Palestinian bees, although by careful selection it might be possible to secure such bees from ordinary Italian stock.

It might be said in this connection that the so-called five-banded bees and Albinos are probably "sports" from the eastern races. They look like them and are cross. They are little more than a curiosity, because commercially they have little or no value from the standpoint of honey production.

In general, it may be said that when bees are extra-light in color, having a predominance of yellow, it may be assumed that they are derived from the eastern races.

Egyptian Races

By some, the Egyptians are said to be the most beautiful bees. Even if they are, they have the reputation of being the crossest. They are slightly smaller than the other yellow bees, not good for honey-gathering, and inferior for breeding. It is very difficult to build them up to a colony of six frames. On account of the mild climate and honey-bearing sources yielding almost the entire year, they do not store much honey. Commercially, they would be of very little use. They greatly resemble the Palestinian bees, but are smaller, and on account of the fuzz-rings they seem to be lighter colored.

Most of the natives of the island of Cypress, Syria, Palestine, and northern Africa keep their bees in bark, clay, or stone cylinders. The brood, of course, will be in the central part of the cylinder and the honey will be stored at each end. When there is a surplus, the honey is cut away almost up to the brood. In the warmer climates the winter problem is not a serious one and the honey can be taken away more closely because the bees in many cases can gather honey almost every month in the year.

Saharan Bees

There is one more race of yellow bees that Baldensperger thinks may be, when imported into the civilized countries, the most valuable bee commercially of any race of bees known. These bees are found in the Sahara Desert on the oases and in the mountains on the north. They resemble the Cyprian bees very greatly, says Baldensperger, but, unlike these bees, are very gentle. In fact, he believes they are the gentlest bees in the world. The fact that they are found in the oases and in the mountains and in comparatively isolated regions makes them a distinct and a pure race because it has been impossible for other bees to mix with them. Located as they are in these isolated localities, they have no insect enemies, no enemies of any kind, and are therefore very gentle.

There is one distinguishing feature about them, says Baldensperger, and that is that they can fly from four to five miles in quest of stores. In fact, they are compelled to do so, as honey and pollen may not be available within a mile and a half or two or three miles, as is the case with most races of bees.

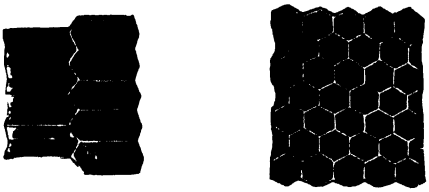
Mr. Baldensperger is hoping to go into the Sahara Desert and bring colonies of them up into Europe whence they will be distributed in America.

The difficulties of obtaining these bees are very great, and some one must know the Beduins and understand their language before he would be able to obtain them. Mr. Baldensperger was reared in Jerusalem and is well acquainted with the Beduins.

East Indian Honeybees

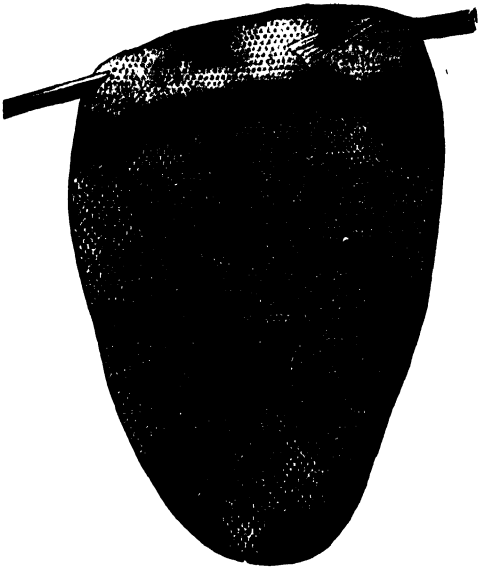
By some authorities this is regarded as a separate species and is called *Apis indica*. By others it is considered to be only a variety of *Apis mellifica*. It is a smaller bee, having thirty-six worker cells to the square inch as against twenty-nine for the Italian. The combs are three-fourths of an inch thick and spaced about $\frac{5}{16}$ of an inch apart. The abdomen is yellow un-

derneath and the anterior part of the segments is orange-yellow. The posterior part is brown and covered with long whitish hairs. The queens are large in propor-



Worker-cells of common East Indian honeybee (Apis indica), natural size.

tion to the workers, and are quite prolific. The drones are slightly larger than the workers and blue-black, with no yellow. The East Indian honeybees are found all over the Indian Islands and the Dutch possessions of the East Indies. They thrive wild in Bengal, where the weather is relatively warm all the year round, and at altitudes having frost and snow



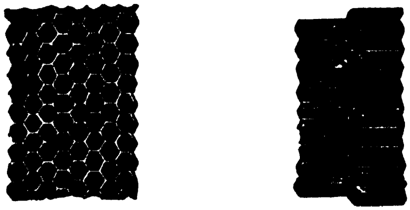
Comb of Apis florea.

in the winter. They are not good bees to handle, as smoke has to be used liberally. They are also kept in hollow logs and tiles after the primitive fashion, as practically all of the eastern races of bees are kept under so-called domestication.

These bees, a good deal like the Egyptians, store very little honey, probably not in excess of ten pounds per colony.

The Tiny or Pygmy East Indian Honeybee

This is the smallest known species of the genus. It builds a single comb usu-



Worker-cells of the tiny East Indian honeybee (Apis florea), natural size.

ally not larger than the palm of a man's hand. They build on bushes, on branches of trees, or under the eaves of huts. There are about one hundred worker cells to the square inch. The accompanying illustrations will give one an idea of the comparative sizes of the combs of the East Indian honeybee and the tiny pygmy bee. These tiny bees are not inclined to sting and have sometimes been called "stingless bees." "They actually do sting," says Baldensperger, "causing some swelling, though the injury is not painful, as in the case of larger bees."

They gather a very small quantity of honey, a single comb yielding only a few ounces. Like the giant honeybees of India, they can not be confined to hives or boxes, as they insist on being in the open air.

Giant East Indian Honeybee

This bee has been called *Apis dorsata* or *Apis zonata*. There appear to be several varieties of them scattered throughout India, Ceylon, Borneo, and the Philippines. They build enormous single combs, five to six feet long and four to five feet wide, the combs hanging from limbs on high trees. The peculiarity of the combs of the giant bees is that their cells are all the same, whether for drones, workers, or queens. which hardly differ in size or color. The author has seen specimens of them in alcohol and would call them a yellowish bee. If one could imagine ordinary Italians as large as a good-sized Italian queen he would get an idea of their size.

These giant bees are migratory, like some birds, in that, when the weather changes, they will migrate to a warmer or colder climate, depending on the season of the year. Whether they, like the birds, go back in each case to the same

nests they formerly occupied is not stated.

Unsuccessful attempts were made by Benton in 1880 and 1905 to introduce these bees into Europe and America. Finally Dathe did so in 1883. The bees did not seem to take kindly to domestication, and since that time no effort has been made to confine them to hives, as they seem to prefer the open air and to hang their single combs on some lofty limb of a tree.

Benton believed that the giant bees might be useful in America in pollinating certain plants with flower tubes too deep to be reached by Italians.

As to the temperaments and habits of these bees there is some difference of opinion. Apparently expert beekeepers have no difficulty in handling them, but the natives seem to regard them as very vicious. They build bonfires under the nest or the one comb, making such a smudge of smoke and heat that the bees will desert the comb, when the natives will climb the tree and cut it down. As much as sixty pounds of honey has been secured.

The bees are very easily stirred up, and, according to the statement of some American soldiers in the Philippines, a single stone thrown at the nest will cause every bee to desert their one comb and rush out in battle array. They will not only sting man and beast, but they will sting inanimate objects, leaving their stings by the hundreds. A single sting is very severe; but, according to expert beekeepers, their sting is no worse than that of the ordinary honeybee. It is also stated that when these bees do rush out to sting they will not go back to their comb but abscond. This makes it easy for the natives to get their honey and wax.

Apparently there has been quite a business in selling wax from the giant honeybees of India and the Philippines. It appears that the natives make a business of gathering the combs and the honey. The wax is melted and sold as ordinary beeswax.

Chinese-Japanese Bees

These are thought to be a variety of *Apis indica*. The Chinese bee, however, is said to differ from the Japanese. Whatever the bees are, both the Chinese and the Japanese much prefer regular standard European races, especially the Italians.

Best Race of Bees

On this point we can not do better than to quote from Doctor E. F. Phillips in his book "Beekeeping." As it accords so perfectly with the author's own views, we give it here entire:

> To answer the question as to which race of bees is best is difficult. For comb-honey production, the German, Carniolan and Caucasian races have the advantage of capping the honey white, but the German bees are specially subject to European foulbrood. Carniolans swarm excessively (especially in comb-honey production), and Caucasians propolize badly. Without going further into the merits and demerits of the various races, it may be as well to give the almost unanimous verdict of American beekeepers, which is in favor of the Italian race. It is probably true that the tests made can not be considered as free from prejudice but the decision was made years ago and no special reason has been presented for changing it. Since this race became popular it has been carefully bred and it is easier to obtain good stock of this race than of any other in the United States. It was the first race brought to America in the effort to improve the early introduced black bees and proved so vastly superior that it soon took a firm hold on American beekeepers. It is doubtful whether any other race will be accepted as better or even as good by the majority of beekeepers and certainly no markedly better race has been tried in this country.

RELATION OF ENVIRONMENT TO TEMPER AND HABITS OF THE HONEYBEE

Through the slow process of evolution, honeybees, like all other animals, have been coming down through the ages modified by environment until more or less fixed types have been developed. Some races of bees are gentle and others are cross. Some swarm excessively and others swarm but little. Some deposit large amounts of propolis and others use very little. Some bees are very restless on the combs, running like a flock of sheep, while others remain perfectly quiet. Some bees store large amounts of honey, while others store but very little, seeming to live from hand to mouth.

Practically all of these special characteristics, says Baldensperger, can be explained by environment covering a long period of years, or perhaps hundreds—possibly thousands—of generations. Baldensperger, in a series of articles for Gleanings in Bee Culture in the early part of 1926, draws some very interesting conclusions to the effect that environment, particularly isolation for thousands of years, has developed distinct types or races of bees. There are some biologists who would not accept his findings; but they are here given for what they are worth.

Let us take the case of temper, or

crossness, of bees. Some races, argues Baldensperger, like the Cyprians, Syrians, Palestinians and Egyptian bees, are very nervous and cross, while other races, like the Carniolans, Caucasians, Italians of northern Italy and of America, and the brown bees of southern France, are comparatively gentle. By looking on the map it will be seen that these cross bees have their native homes in tropical or semi-tropical countries, where there are wild animals, snakes, lizards, and predaceous insects of many kinds. Naturally the bees in such an environment have to fight for their very existence. Down through the ages they have developed a temperament that is expecting onslaught from insects and animals, and are therefore prepared to fight for their lives and their homes. The bees of the island of Cyprus, Asia Minor, and Palestine and northern Africa have all kinds of insect enemies and are usually cross. Even Italian bees found on the island of Sicily or in southern Italy are much crosser than those bees found on the southern slopes of the Alps, where there are few or no insect enemies. The crossest bees are those developed in a special environment where there is little opportunity for crossing with other races. Bees on the island of Cyprus are surrounded by water. Bees on the island of Madagascar are likewise surrounded by water. Bees in Egypt are surrounded by water and by sandy desert wastes. The bees of Syria and of Palestine are surrounded by water, by mountains and by sandy wastes. In all of these cases there has been an opportunity for the development of fixed types, says Baldensperger, all of which types are prepared to defend themselves, and do so. They are the result, in the language of Darwin, of "the survival of the fittest," all others having been cleaned out by their enemies.

Now let us take the types of gentle bees. We find them in most cases in the colder climates, surrounded by mountain ranges and by water so that fixed types are developed. In these colder climates there are very few insects, comparatively speaking, and few animals that have a taste for honey. The Italians of northern Italy, the Caucasians, and the Carniolans are all shut in by mountain ranges and to a large extent are pure types. They have few or no insect enemies to fight, and when man opens the hives they are not inclined to sting as do bees where insect enemies are numerous.

"In the same way," says Mr. Baldensperger, "the Saharan bees are surrounded on the one side by desert wastes and by mountains on the other." While the climate is tropical, the number of insect enemies that can exist in the desert or in the mountains is very small. These bees, by reason of their development upon the mountainside on the North and by their development on the oases, are very gentle. They are not expecting trouble because they are not persistently annoyed by insect enemies, consequently, says Baldensperger, they are a very gentle race. The same can be said of the Italians of northern Italy, the Italians of America that have been developed for gentleness by selection, the Caucasians, the Carniolans, and last, but not least, the brown bees of central Europe.

It will be found that some races of bees in semi-tropical countries are inclined to deposit a large amount of propolis. This is found especially in the case of the Tunisian or Tellian bees, which keep out their insect enemies by putting up little pillars of bee glue in front of their entrances. In some cases glue is so sticky that other insects can not get through, while the bees go through readily. It can be readily seen in the case of the Tunisians that a trait has been developed by environment that would be entirely unsuited for commercial beekeeping, especially in the production of comb honey.

For some reason the Caucasians, a gentle race, deposit a large amount of propolis, while Carniolans deposit very little. There must be some reason from the standpoint of environment why this is so. In respect to propolis, the Italians of northern Italy take somewhat of a midway ground.

Environment and Its Effect Upon Honey-gathering Qualities

It will be noticed likewise that some bees will store very much more honey than others. For example: The East Indian bees and the Egyptian bees store very little honey for the very good reason that honey can be secured nearly every month of the year and they need, therefore, to work only from hand to mouth. The colonies are not very strong; they store just enough to take care of the gaps between the flows and the re-

sult is that they never have more than ten or fifteen pounds of honey. On the other hand, the Italians of northern Italy, the brown bees of southern France, the Caucasians, and the Carniolans will store relatively large amounts of honey because for ages they have been subjected to long cold winters. It was necessary for them to acquire the storing instinct or die out. The bees of Syria and Palestine are all raised upon the mountain sides, where the atmosphere is cold and where there may be long periods in which there will be no honey coming in. They likewise have acquired the storing instinct. The Saharan bees of the mountains of northern Africa are required to store a large amount of honey in order to carry them through until the next season.

It is therefore easy, says Baldensperger, to explain why some bees store large amounts of honey and others gather only just enough for temporary needs.

The question might be raised why the bees of the island of Cyprus are good workers, or reputed to be such. Baldensperger reports that the amount of forage on the island is very scanty and that bees, in order to survive at all, must be good workers. When these bees are let loose in a locality where there is plenty of forage they take advantage of the situation and store large amounts of honey.

The Effect of Environment on Wintering

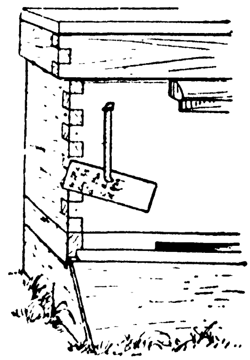
It is easy to see that bees reared in colder climates, especially on the mountain sides, would not only have to store large amounts of honey to carry them over from one season to another, but would have to develop hardy qualities that would stand the cold. Ordinary honeybees do not hibernate, but they do pass into a stage of winter sleep. (See Temperature and Wintering.) Some bees are necessarily better for standing the cold than others. We find in this class the brown bees of Europe, the Italians of northern Italy, and the American Italians developed for their qualities of honey production, wintering qualities, and all-around gentleness.

Taking it all in all, it is easy to see why the Italians are such a popular race. They were reared in the first place in northern Italy upon the southern slope of the Alps; have been further developed by breeding and careful selection by American queen-breeders to a point where they surpass any other race of bees in the world. Many Europeans are unable to understand why Americans secure such large crops of honey. There are two reasons for this—a highly developed race of bees, and a locality or localities where large amounts of honey can be secured.

RECORD KEEPING OF HIVES.—Commercial honey producers and even the small back-lot beekeeper with a few colonies as a rule, keep no records other than the age and quality of the queens. If all colonies are of even strength by the use of the food-chamber and a close watch is kept during the honey flow to see that all have plenty of room for storage of honey, very few notations are needed.

Somewhere inside the cover the date when the queen was introduced or raised should be made with a pencil. Usually when a queen is a year old, especially if she is two years old, she should be replaced by a young queen and the date marked. If a queen, even though two years old, shows a good record in honey production, she should be kept and used as a breeder for new stock.

For queen-rearing or for scientific research work, careful record should be kept. A well bound leather covered note or better, a loose leaf memorandum book, something that can easily be carried in the pocket, will answer nicely. The objection



The wooden tablet is fastened to the hive.

to any form book is that it may get lost or temporarily misplaced. It is the usual practice of queen breeders to make the record on a wooden tablet attached to the hive or nucleus.

But these wooden tablets will blow off the hives, and become lost. This difficulty is easily overcome by the use of little spring clips made of brass; and in lieu of anything better, the ordinary steel super springs coated with paint make a

very good substitute. Each spring clip should be fastened down with a staple. The advantage of these clips is that they not only hold the tablets fast to the hive, but they enable one to place the tablet in front or on top. When a colony needs attention at the next visit, a red tablet is placed on top of the white one bearing the record. If a colony needs feeding, a blue tablet will be used; if it is queenless, a green one; and thus one can use a great variety of colors to indicate as many conditions of the colony. In most cases a red tablet may be used to show anything that requires immediate attention.

REQUEENING.—It has been truly said that the queen is the soul of the colony. Without a genuinely good queen, young and vigorous, in each colony, the maximum crop of honey can not be secured. It pays, therefore, to requeen before the old queen fails. (See Introducing.)

Under the present modern apiary management queens are called upon to lay an enormous number of eggs during a single season. This is due to the use of large breeding room with more available comb space for egg laying. In many and most instances double brood chamber hives should be used during the height of brood rearing. (See Food Chamber.) Queens under such conditions soon reach the end of their usefulness and must be replaced.

How and When to Requeen

Some beekeepers with modern equipment depend on the swarming or supersedure impulses for the rearing of young queens to replace old ones. (See Supersedure.) Where the owner of an apiary is at hand to hive swarms on parent stands and to manipulate the parent hives properly, good crops of honey may be secured. The main disadvantage to swarming is that it may occur when least expected and unless queens' wings are clipped swarms go to the woods. Swarming should really be controlled in order to keep the working force undivided. (See Swarming.)

As a rule, queens reared under the supersedure impulse are of good quality. The main objection to this method of requeening is that frequently old queens are superseded in the spring during the heavy brood rearing season when it is so necessary for queens to lay to their maximum capacity. The population of the hives is thus reduced somewhat and this in turn reduces the honey crop.

There are differences of opinions as to how and when requeening should be accomplished. Since thousands of queens are produced and sold by commercial queen breeders, a large number of beekeepers buy these queens in mailing and introducing cages to requeen their apiaries. Some practice requeening annually and others requeen every two years. Requeening should occur in the North at least six weeks before the first killing frost in order to give the queens a chance to produce plenty of young bees before winter. This helps materially to insure successful wintering of bees. In some sections of the West, in the alfalfa and sweet clover regions, requeening takes place in late spring prior to the major honey flow. Young queens introduced at that time are likely to continue brood rearing longer than old queens. This is especially true during a long drawn-out honey flow.

Requeening by the cage method will be more successful during a honey flow than during a dearth of nectar; but there are a few disadvantages to the cage method of requeening. It is practically impossible to get 100 per cent acceptance. A few colonies may become hopelessly queenless in this process of requeening. It is exceedingly difficult for beginners to find the old queens before introducing new ones.

Then, too, there is the danger of buying queens that may be improperly reared, or, perhaps produced under abnormal weather conditions. Such queens may be superseded soon after being introduced.

REQUEENING WITHOUT DEQUEENING.—This method of requeening has a universal appeal because it eliminates the labor of finding queens. It is worked in connection with the food chamber. (See Food Chamber.)

Requeening should take place during the active season. The old queen is permitted to occupy the combs of the brood-chamber and food chamber during the spring months prior to the main honey flow. When this starts and it is necessary to add supers, the queen, with the larger proportion of the brood, is confined to the lower hive or brood-chamber proper by the use of a queen excluder. The food chamber, which at this time, should contain some fairly well-filled combs of honey and from three to five combs of brood (the amount depending on the strength

of the colony) is given a ripe cell and set off onto a bottom board a few feet away and facing the direction as the old hive. A hive cover is, of course, put on the food chamber hive.

The old bees in the food chamber will return to the parent stand, but enough bees will remain in the fool chamber hive to care for the brood and to rear a new queen from the cell. A stock of queen cells should be raised in advance. (See Queen Rearing.)

At the close of the honey flow, after the surplus honey is removed from the parent colony, the food chamber hive with young queen is set back onto the parent hive. When this uniting takes place in late September or early October, it is unnecessary to put a newspaper between the two hives. (See Wintering.)

The young queen in the upper or food chamber hive will in most cases be retained and the old queen below will be killed. The theory is that the bees in the upper hive finding it necessary to use the entrance of the lower hive discover the old queen below as they are passing through and kill her. The bees in the lower hive not having much occasion to enter the upper hive, may not discover the young queen above and therefore she is not molested. In any event the young queen is retained in most cases and thus requeening as well as providing ample winter stores for the colony is accomplished at one stroke.

It is obvious therefore why beekeepers generally are interested in this method of requeening. It reduces labor and simplifies apiary management. It lends itself naturally to comb honey production as well, because in producing comb honey it is necessary to reduce a double-story hive down to a single story brood-chamber, while the comb honey supers are on the hive during the honey flow.

REVERSING.—This, as the term signifies, is a scheme or plan for inverting, or turning over, the comb. It may be accomplished by inverting the frames individually or the whole hive at one operation.

Reversing began to be discussed in 1884; and for three or four years following there was much said on the subject. Reversible frames and reversible hives were invented by the dozen. Some of them were quite ingenious, while others were clumsy and impractical.

Taking into consideration the fact that the bees store their honey immediately over the brood and that, as a consequence, their combs at this point are much better filled out, certain beekeepers conceived the idea of turning the combs upside down at frequent intervals. "Why," said they, "when the combs are reversed, bringing the bottom-bars uppermost, the combs will be built clear out to the bottom-bars, and the honey next to the top-bar, which is now at the bottom of the hive, will be carried up into the supers, just where it is wanted." This seemed very nice in theory, and even in practice it seemed to be partially carried out. Many beekeepers reported that, when the combs were reversed, the bees, rather than have the honey in the bottom of the combs, near the entrance, and accessible to robbers, would uncap it and take it up into the sections. Unfortunately, honey carried above was often poor and dark in color. Many times also the bees did not carry the honey above but allowed it to stay at the bottom of the hive, so that the only real advantage secured was getting the combs filled actually to the bottom-bars, now at the top.

A very few claimed that reversing when done at the proper time, would destroy queen-cells, and so control swarming. But this worked better in theory than in practice.

The only real and direct advantage of reversing is in getting combs filled out solid in brood-frames. (See Manipulation of Colonies.) When hunting queens it is much easier to find one where there is no horizontal space between the edge of the comb and the bottom-bar, and no holes to furnish her hiding-places. Moreover, having combs filled out solid gives better fastening to the frame and increases the capacity of the hive just in proportion to the new comb built after reversing. Nearly every frame that is not reversed is liable to have a space of ½ inch or ⅜ between the top of the bottom-bar and the comb; and this is a waste that ought to be utilized if possible. To a certain extent this space can be filled in non-reversing frames by having sheets of foundation reach from frame-bottom to top-bar wired in with perpendicular wires; but even such combs are never as well filled as those reversed. Having the combs built in the upper story causes the bees to build them down to the bottom-

bar much better than when built in the lower story.

Several good reversible frames have been proposed; but no one should think of adopting any of them unless it has some points of merit besides the one exclusive feature of reversing. A reversible frame that is not good for all-around use—easy to handle—would be very unprofitable.

The fact that none of these frames are in use to any extent would seem to argue that the advantages of reversing are more theoretical than actual.

How to Reverse Ordinary Frames So That Combs Will be Built Down to the Bottom-bars

The ordinary frame in general use, as before stated, will have a space of from ¼ to ½ inch between the bottom edge of the comb and the bottom bar. There is only one way to make the bees fill this out, and that is to turn the combs upside down for a short time. With the Hoffman frames, the hive-body and all containing the frames can be inverted. To prevent the frames from sliding down onto the bottom-board when the whole thing is reversed, a couple of cleats should be placed one at each end, equal in thickness to the bee-space on top of the frames and the bee-space in the bottom-board. An ordinary bottom, after the cleats are in place, should be put on top of the hive in place of the cover, after which the bottom-board, hive, frames, and all may be turned the other side up for a week's time. The time selected for doing this should be just at the beginning of the honey flow. After the frames have been upside down for about a week they can be set back to their normal position.

A few beekeepers do not like to have these empty bee-spaces under the bottom-bars, for two reasons: They think this space is an actual waste; and, second, it provides an excellent hiding place for the queen when it is desired to find her to clip her, or otherwise see how she looks.

RIPENING HONEY.—See Nectar, Bee Behavior, Entrances, Honey, Science of, and Ventilation.

ROADSIDE SELLING OF HONEY.—See Marketing.

ROBBING.—As the term signifies, "robbing" is an act or series of acts by which bees pilfer or steal from each other, or from any source where sweets in the form of jam, jellies, syrup, or honey, are left exposed. Like some human beings, when there is no nectar to be found bees find it easier to steal than to work. The passion for stealing or robbing if neglected, becomes a habit—a habit that is exceedingly hard to break.

When bees discover that a large amount of sweets can be secured during a dearth of nectar they are quick to profit by it; and in the space of a few minutes they may start an uproar. This not only means pillage, but death to the bees and stings to their owners.

Paul says that the love of money is the root of all evil; and similarly the love of honey on the part of the bees is a root of a great deal of the evil that takes place in bee culture. When they find it easier to help themselves to the results of the honest toil of others they will enter into the business of plundering without scruple.

It has been shown that a single bee may visit over 100 clover-heads before it obtains a load sufficient to carry to its hive. It is probably true that during a great part of the season a bee will be from a half to a full hour, or, during unfavorable seasons, as much as two hours, in obtaining a single load. The time during which a bee may be absent is very variable. If the nectar secretion is heavy it will return much quicker than if it is light. Is it at all strange that a bee, after having labored thus hard during the fore part of the day, should, in the afternoon, take a notion to see if it could not make a living in some easier way? Would it be very much worse than many types of humanity? As the bee noses around other hives it catches the perfume of the honey other bees have gathered, and, it figures out that, if it could abstract some of this, unperceived, and get it safely into its own hive, it would be so much the richer.

With all their wonderful instincts, no one has ever been able to perceive that the bees of one hive have any spark of solicitude as to the welfare of their neighbors. If, by the loss of a queen, the population of any hive becomes weak, and the bees are too old to defend their stores, the very moment the fact is discovered by the other bees they rush in and overpower the sentinels with the most perfect indifference, plunder the ruined home of its last bit of provision,

and then rejoice in their own home, it may be but a yard away, while their defrauded neighbors are so weak from starvation as to fall to the bottom of the hive, being only just able to attempt to crawl feebly out at the entrance. Had it been some of their own flock, the case would have been very different indeed; for the first bee of a starving colony will carry food to its comrades, as soon as it has imbibed enough of the food furnished to have the strength to stagger to them.

Suppose a robber bee, in prowling around in the afternoon during a dearth of nectar, should find a colony so weak or so careless that it could slip in unobserved, and get a load from some of the unsealed cells, and get out again. After it has passed the sentinels outside it usually runs little danger from the inmates, who seem to take it for granted that every bee inside is one of their number. There is danger, though; for should the robber betray too great haste in repairing to the combs of honey they often suspect something; so it assumes an indifference it is far from feeling, and loiters about very much as if it were at home, and finally with a very well-assumed air of one who thinks he will take a lunch, it goes to the cells and commences to fill up. Very often, when it gets pretty well "podded out" with its load some bee approaches, apparently, to see if all is right. When the robber once gets its head into a cell, however, it seems to have lost all sense or reason; and if it is discovered at this stage to be a stranger and a thief, it is often pounced upon and stung with very little ceremony.

How do bees know a stranger from one of their own number, where there are so many? By the sense of smell; and the stealthy behavior of the intruder. While the sense of smell is doubtless the predominating clue, they depend greatly on the action and behavior of a bee, much as men do when judging of the responsibility of a man who asks to be trusted. One can give a very good guess, simply by his air or manner, or even by the sort of letter he writes.

If a robber bee is suspected, and a bee approaches for the purpose of satisfying itself, it is a very critical moment, and one becomes intensely interested in watching the performance. The robber will stand its ground if it is an old hand, and permit itself to be looked over with wonderful indifference; but one who has watched such scenes closely will detect a certain uneasiness, and a disposition to move slowly toward the entrance, that it may be the better able to get out quickly, when it discovers things to be too hot for it inside. If the bee that first suspects it concludes it is an interloper, it begins to bite it, and grab hold of its wings to hold on until others can come to help. The thief has now two chances to escape, and sometimes it seems meditating which to adopt; one is, to brave it out until they shall perhaps let it alone, and then slip out unobserved. The other is to break away and trust to its heels and wings. The latter plan is the one generally adopted. One that has been many times in such scrapes will usually get away by an adroit series of twists, turns, and tumbles, even though three or four bees have hold of it at once. Some of these fellows, by a sudden and unexpected dash will liberate themselves in a manner that is even wonderful, and then, as if to show their audacity, will wheel about and come back close to the noses of their captors of a minute before.

In case the bee secures its load and makes its way out unobserved, it gets home very quickly, rushes into the hive, gives the wag tail dance (see page 67) and under the influence of this new passion for easily replenishing its hive with the coveted sweets, it rushes out with a vehemence never known under any other circumstances. Back it goes and repeats the operation, with several of its comrades at its heels. Does it tell them where to go? (See Bee Behavior, pages 66 and 67.)

When a bee comes into the hive in such unusual haste, also podded out with its load in a way rather unusual when obtained from the flowers, its comrades at once notice it, and, either from memory or instinct they are suddenly seized with the same kind of passion and excitement.

Those who have had experience at the gambling-table, or in wild speculations of other kinds, can understand the fierce and reckless spirit that stirs these little fellows. The bees, when they see a comrade return in the way mentioned, know, without any verbal explanation, that the plunder is stolen. Anxious to have "a fin-

ger in the pie," they tumble out of the hive, and look about, and perhaps listen, too, to find where the spoil is to be had. If they have, at any former time, been robbing any particular hive, they will repair at once to that; but if it is found well guarded, those used to the business will proceed to examine every hive. (See Bee Behavior.)

How Bees Communicate

Of course, bees have particular notes, as for joy, sorrow, anger, despair, etc., which are produced by the wings, usually when flying; but probably they are unable to communicate to each other more than a single idea. In other words, they have no faculty of telling their fellows that a lot of honey is to be had in a feeder at the entrance, and that it would better be brought in quickly or other bees may find it. A bee goes out in the spring, and, by smelling around the buds, discovers honey and pollen; when it comes into the hive the others see it and start out to hunt up the source of supply in a similar way. (See Bee Behavior, page 67.)

When Bees Will Not Rob

By reading Anger of Bees and Bee Behavior, page 67, one will get a very good idea of the causes that start bees to robbing. Read also Bee-hunting and Feeding. As a general thing, bees will never rob so long as plenty of honey is to be had in the fields. During a bountiful flow the author has tried in vain to get bees to take any notice of honey left around the apiary. At such times one can use the extractor right in the open air, close to the sides of the hives, if need be. On one occasion at Medina a comb of unsealed honey was left on the top of a hive from morning until noon, and not a bee touched it. It seems they preferred to go to the clover fields in the regular way rather than to take several pounds from the top of a neighboring hive. It can readily be supposed that they did not have to visit anything like a hundred blossoms at this time, and perhaps they secured a load in going to not more than a dozen.

After the season begins to fail, one must expect that every colony in the apiary will be tried. As a rule, any fair colony will have sentinels posted to guard the entrance as soon as there is any need of such precaution. The bee that presumes to think it may enter for plunder will be led off by "the ear" and this will be repeated until it learns that there is no chance for robbing at that house. At the close of the honey harvest precaution should be taken that there are no weak colonies, especially if they are queenless, that may be overpowered, for one such may start the fashion of robbing, and make it much harder to control. An apiary, like a community, may get so demoralized that thieving becomes a universal mania. "A stitch in time" will save a great many more than nine in this case. The space occupied by the bees should be in proportion to their numbers. The entrance also should be in proportion to the size of the colony. They should have only as many combs as they can cover if they are to defend themselves properly from either moths or robbers. Colonies without either queen or brood are not apt to fight for their stores very vigorously. It is hardly necessary to repeat what has been said about Italians being better able to defend themselves than black bees. A few Italians will often protect the hive better than a whole swarm of black bees.

How to Know Robber Bees

It sometimes puzzles beginners exceedingly to know whether the bees that come out are robbers, or inmates of the hive out for a playspell. There are times when a playflight looks very much like robbing. (See Playflights of Bees, Drifting, and Bee Behavior, page 66.)

When the robber bee approaches a hive it has a sly, nervous manner, and flies with its legs spread in a rather unusual way as if it wanted to be ready to use its heels as well as wings if required. It will move cautiously up to the entrance, and quickly dodge back as soon as it sees a bee coming toward it. If it is promptly grabbed on attempting to go in, never fear. When a bee goes in and it can not be determined whether it is a robber or not, a close watch should be kept on all the bees coming out. This is a sure way of telling when robbers have got a start, even at its very commencement. A bee, in going to the fields, comes out leisurely, and takes wing with but little trouble, because it has no load. Its body is also slim, for it has no honey with it. A bee that has stolen a load is generally plump and full; and as it comes out it has a hurried and "guilty look." Most of all, it finds it a little difficult to take wing, as bees ordinarily do,

because of the weight. In Bee-hunting it is related how a bee, laden with thick undiluted honey, will stagger under its load before it can take wing for the final trip home. The bee, when coming out of the hive with honey it has very likely just uncapped, feels instinctively that it will be quite apt to tumble unless able to take wing from some elevated position, and therefore crawls up the side of the hive before launching out. When first taking wing it falls a little by the weight of its load before its wings are under control, and therefore, instead of starting out as a bee ordinarily does, it takes a downward curve, coming quite near the ground before rising safely and surely. With a little practice one can tell a robber at first glance by its way of coming out of the hive and taking wing.

How to Tell Where the Robbers Belong

If one is a bee-hunter he will probably line them to their hive without any trouble; but if he is not, he can easily find from which hive they come by sprinkling them with flour as they come out of the hive being robbed. Watch should be kept on the other hives, to see where the floured bees are going in. If the robbing is confined to one or two colonies, as is often the case, they should be put down cellar and kept there for several days where they can not incite other colonies. Reference will be made to this further on.

Once a Robber, Always a Robber

After bees once get into the fixed habit of robbing it is a mistake to let them out again; for no sooner are they out than they are at their old tricks again. It is better to confine them and then after they have been imprisoned for 24 hours they may be brushed down into a box from the screen or from any portion of the building in which they have clustered. They should then be carried to an outyard. It is not advisable to let them loose again in the same yard where they have learned their bad tricks of stealing. If allowed their liberty they will be continually prowling around for days to see where they can effect an entrance to the honey house or an unguarded hive. It may be cheaper in the end to kill them outright, especially if there are not more than half a pound of bees. If there are many more, it may be desirable to save them; but they should not be let loose again in the same yard. If taken to another yard they will cause no trouble.

Robbing of Nuclei or Weak Colonies

There is another kind of robbing that is much more common, and which is apt to perplex the beginner more than anything else, and that is the onslaughts that are often made on weak colonies or those that are disinclined to make a defense, especially if queenless. Nuclei with large entrances are especially subject to the attacks of bees from strong stocks, and may be cleaned out entirely before the apiarist discovers the mischief. By that time the whole apiary will be in a perfect uproar. As soon as the supply of honey has been exhausted in the one nucleus the robbers will hover around all other entrances, and on finding one poorly defended will get in more bad work. During a dearth of nectar there are always some bees that make a business of smelling around, and it is a wise precaution always to have the entrances of nuclei contracted to a width through which only one or two bees can pass at a time.

One of the most prolific causes of robbing is a warped cover on an old hive, the corner of which has split open. All such makeshifts should be replaced. In an emergency a handful of mud plastered into the opening or crack, or some cotton stuffed in, will go a long way toward preventing serious trouble later on. During a good honey flow cracks large enough for bees to get through do no particular harm, but during a dearth of honey extra precautions must be taken. Weak colonies especially can not defend several entrances, and that is why poorly fitting covers or leaky hives must not be tolerated. The robbers seem to realize that the regular entrance is more likely to be well guarded, and that is why they are often seen trying to crawl through some unguarded crack.

How to Stop Robbing

As to the best mode of procedure, a good deal will depend on circumstances. When bees in the whole apiary are robbing in a wholesale way from the honey-house, or from any place where a supply of honey or syrup is kept, the obvious remedy is to cut off the supply.

Bees soon stop robbing when all sweets within their reach are removed or so protected that they can not get at them; but even then the apiary will be out of balance for the rest of the day, and more or

less for two or three weeks following. because the bees will be trying to find where they can get more sweets.

Sometimes robbing is started by some one in the neighborhood making sweet pickles, canning fruit, or doing anything that causes a strong odor of sweet or sour during its preparation. The only thing the beekeeper can do is to have the house screened; or, if the case is very bad and the bees keep on "sticking their noses into other people's business," the entrances of all the hives should be smoked with tobacco smoke. Half a dozen puffs of smoke should be blown into each entrance, one after the other. In half an hour the dose should be repeated. This will cause the bees to quiet down until such time as the canning or the pickle-making is over at the house where the bees are "making themselves too familiar."

The best treatment for general robbing throughout the apiary is prevention. The screen door and other openings into the honey-house should be self-closing. Unless they are, some one will be almost sure to forget and leave one of them open. If the doors are not self-closing, all the honey or syrup stored in the building should be put into hives, shipping cases, cans, barrels, or any receptacle where bees can be kept from helping themselves; then, if perchance the door is left open, no harm will come.

Let it be supposed that a colony has been overpowered, and that its own bees are making no defense, realizing, probably, that resistance is useless. If anything is to be done to save the colony, it must be done quickly. One way is to grasp a handful of long grass, strew it closely around the entrance, and then spray or sprinkle a dipperful of water on it and scatter more wet grass over the entrance. A very little carbolic acid added to the water makes the spray more offensive to robbers. The invaders will not, as a rule, crawl through the wet grass to get into the hive, while on the other hand those that have already entered the hive will get out and return to their homes. In the meantime the regular inmates of the hive, as soon as they are given a little assistance, will begin to set up a defense. The grass should be kept wet for at least an hour or two, and possibly till sundown; but before strewing the grass the entrance should be contracted so that only one or two bees can pass at a time. The entrance should never be closely entirely, no matter how bad the bees are robbing. On a hot day the large number of robbers in the hive, together

A cage to set over a hive being robbed and to catch robbers.

with the regular inmates, would be almost sure to smother to death.

Another and better way to treat colonies or nuclei that are not making a good defense is to carry them down cellar or put them in any cool place where they will have an opportunity to recover themselves, and where, too, robbers can not continually pester the life out of them. In 24 hours the robbers in the yard will have quieted, when the nucleus or robbed colony can be taken out and set back on its stand. But at this time the entrance should be contracted to a space just wide enough so that only two or three bees can pass at a time.

A still better plan for the treatment of a colony that is being overpowered by robbers is to set a wire-cloth cage or tent over it. This cage need not be larger than will cover the hive. The illustration shows the style used by the authors. One such cage is kept in the yard ready for an emergency of this kind.

There is no robbing except when the regular apiarist is temporarily away and a new man has been left in charge. Such a man or boy will sometimes let robbing get well under way, not knowing that trouble is brewing. In very short order it will be apparent that the colony or the nucleus is not making a defense. Sometimes even a strong colony will be taken by surprise and before it is aware of what is happening the robbers will be piling into the hive at a furious rate. At other times there are not enough bees in a nucleus to make a successful defense. Such colonies or nuclei need help, and that right speedily. If one has a wire cage he can set it over the hive, and that immediately stops any more robbers from getting in. As soon as the marauders in the hive fill up, they will rush out of the entrance pell-mell; but instead of going back to their own hive they are imprisoned in the cage. In the meantime there will be a big horde of robbers outside of the cage. Raise the cage up for thirty or more seconds, when all the outside robbers will pounce on the entrance. Right here the reader may think this is a mistake. The scheme is to catch every robber that has been carrying on the business of stealing for the last few minutes or half-hour, so that as they return from their hive the cage is lifted up at intervals, when the robbers rush in. The bees that have been imprisoned will cling to the top of the cage, even though it be lifted for the moment. In the meantime their number will be reinforced by more robbers coming out of the hive. In the space of about thirty minutes, if the robbing has not been going on too long, every robber will be in the top of the cage, and there they will stay. It is a serious mistake to let such bees loose again, for they will immediately go back to their hives and return to attack the colony that has been overpowered.

Toward night the cage is lifted off the hive and set down carefully till the next day, when the bees will be found clustered up in the top of the cage, perhaps in one corner. After using a little smoke they are scooped off with a dipper and dumped into a box. They are then carried to an outyard, where everything will be strange to them, and given to a colony that needs a few more bees, the precaution being taken, however, to cage the queen, as the new bees might kill her.

Some good beekeepers doubt whether it is best to let these robbers loose after they have once been trapped. Where there are very many of them it would be folly to destroy them. If only a few they should be killed.

A Convenient Robber Cage

This consists of a light framework of ⅞-square stuff held together at the intersections by means of three-cornered blocks. (See page 633.) It is then covered with wire cloth, and across the top a strip is nailed to provide a handle so the cage may be lifted up with one hand. It is advisable to have in addition one or two larger cages—big enough to take in a man while he is operating over the hive. These cages may be of various sizes, but they should be light enough so that one can carry them around easily and squat over a hive to be manipulated. The larger cages should be made in the same way as the small cages, of ⅞-square stuff braced at the intersections by three-cornered blocks, except that the top need not be covered. Cross-rails on each side two feet from the bottom serve as convenient handles, so that the man on the inside can pick up the cage and walk from one hive to another. The use of cheesecloth is quite as effective as wire cloth for these large cages, and much cheaper.

With the large cages it is not necessary to have the top covered. The average robber that is supposed to make trouble

will hover along on a level about the top of the hive that is being operated. It does not have sense enough to rise up and dive down over the top. At the same time bees that belong to the hive that is being manipulated will easily escape. On the other hand, the cages that have tops will cage the bees so they will be bumping around the head of the operator. Unless they are actual robbers, it is better to let them loose; and as soon as the operator has left the hive they will go into their own entrances.

For raising queens these topless cages are very convenient when the robbing season is on. The queen-breeder, while

Open top robber cage.

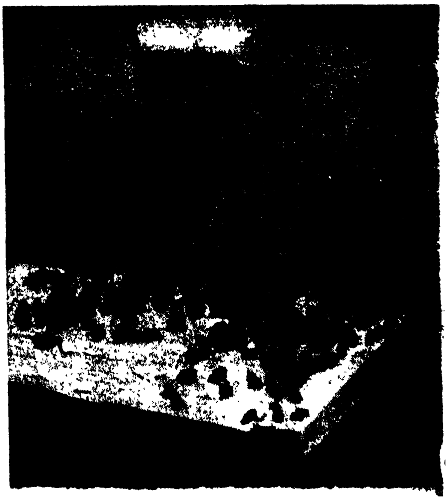
he is on the inside of one of these cages, can work over a hive as long as he pleases, secure from robbers. If he uses the cage continually, robbers will seldom get a taste of honey; and therefore there will be little or no trouble.

Exchanging Places with the Robbing and Robbed Colonies

Trying to people the house-apiary in the fall, the author had trouble with one certain colony. In fact, when robbing was going on anywhere it was sure to be these hybrids that were at the bottom of the mischief. After trying every plan recommended, and still finding these fellows would persist in pushing into every new colony started, the idea occurred that, on the principle that it takes a rogue to catch a rogue, it would be well to try to see how these would repel other robbers. The greater part of the combs were taken from the robbers, bees and all carried into the house-apiary, and put into the hive which had been robbed. The effect was instantaneous. Every laden robber-bee that went home with its load, on finding the queen and brood gone from the old stand, at once showed the utmost consternation, while the passion for robbing was instantly changed to grief and moaning for the lost home. The weak colony which they had been robbing, and which had only a queen-cell, was carried to them, and they soon took up with it and went to work. The robbers, newly domiciled in the house apiary, repelled all invaders with such energy and determination that the rest seemed to abandon the idea which they doubtless had previously formed, viz., that the house-apiary was a monster hive but ill garrisoned, so we had very little trouble afterward. Before they were transposed, as mentioned, we had serious thoughts of destroying their queen, simply because they were such a pest; but the year afterward this colony in the house-apiary gave over 100 pounds of comb honey.

How to Know When a Hive Is Putting Up a Good Defense

The cut shown below is a good illustration of how a powerful colony will



A colony that is ready to meet any kind of onslaught from robbers. Robbers had hovered around the entrance. The result was, the guards were out in good force to repel the attack.

deploy its sentinels or guards during the time when other colonies near by are being robbed. This colony is prepared for any kind of an onslaught; for the minute that a robber hovers over the entrance it is promptly met in mid air by one of the sentinels. They immediately clutch in a rough-and-tumble fight, drop to the ground, roll over and over, and lucky is the robber if it gets away without having its hair or legs pretty vigorously pulled. Such "a warm reception" will discourage any would-be robber from tackling that colony again. The entrance is rather wide open and the colony is strong enough to put up a defense and a vigorous one at that. If the colony were not so strong it would be proper to contract the entrance as shown elsewhere under Entrances to Hives and Wintering.

How to Remove the Robbing Tendency by Outdoor Feeding

When honey is coming in there is no robbing; but as the nectar supply stops, bees begin to pry around to find what they can steal. At such times, when hives are opened for examination robbers will be about, and if the combs are exposed very much by such handling they will pounce upon the hive and combs in great numbers, and then attack the entrance after the hive is closed. If one is trying to rear queens the results will be discouraging. Bees get cross, refuse to start cells (or, if built out, tear them down), kill off drones and destroy drone brood.

The fact that there is no robbing when honey is coming in suggests the remedy; viz., feed outdoors a thin syrup of the consistency of raw nectar.

What Happens if Robbing is Not Stopped

When robbing is under genuine headway, the honey of a strong colony will disappear in from two to twelve hours; the bees will then starve in the hive, or scatter about and die. That is not all; when the passion is fully aroused robbers will not hesitate to attack the strongest stocks, and bees will be stung to death in heaps before the entrances. This may finally put a stop to it, but they may push ahead until every hive of the apiary is in an uproar. At such times the robbers will attack passersby in the streets, and even venture an attack on cats, dogs, hens, and turkeys. Like the American Indians when infuriated at the sight of blood, every bee seems to have a demoniacal delight in selling its life while inflicting all the torments it possibly can, feeling sad only because it can not do any more mischief.

The Remedy

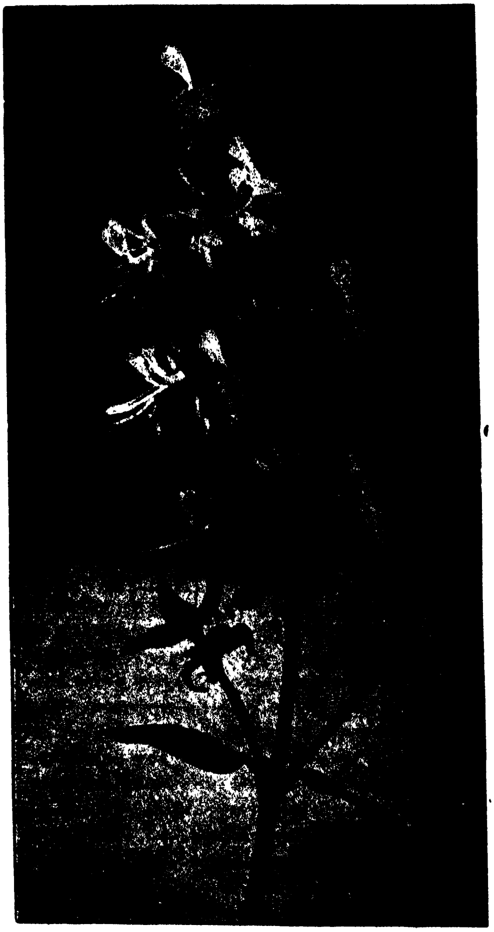
The worst robbing time seems to be after the heaviest or main honey flow is over, when bees become especially crazy if they get even a smell of honey left carelessly anywhere near the hives. One who has never seen such a state of affairs can have but little idea of the furious way they sting every thing and everybody. The remedy is to get a good smoker and put in enough fuel to insure dense smoke; then, using one hand to work the smoker bellows, with the other, contract the entrance of every hive that shows any indications of being robbed. Shut up every bit of honey where not a bee can get at it, and do the work well; for at such times they will wedge into and get through cracks that would make one think inch boards were hardly protection enough. Be up betimes next morning to see that all entrances are close and small, and that all the hives are bee-tight. An experienced man will restore peace and quietness in a very short time to such a demoralized apiary. Black bees are much worse than Italians, for the latter will usually hold their stores against any number of assailants; good, strong, well-made hives filled with Italians, with plenty of brood in each, will be in little danger of any such "raids," although the author has seen the wounded and slain piled up in heaps before robbers would desist and give up trying to force an entrance. (See Anger of Bees.)

ROCKY MOUNTAIN BEE PLANT (*Cleome serrulata*).—See "Honey Plants of North America."

ROYAL JELLY.—See Queens; also Queen-rearing.

S

SAGE (*Salvia*).—Sage honey, which is widely known for its mild flavor in Europe as well as in America, is a product peculiar to California. In a good year many carloads of it are sent eastward for blending with other bottled honeys. It is prized because it is light in color, mild in flavor and because it is a non-granulating honey like tupelo. While the black sage occurs to a limited extent on Mt. Diablo near San Francisco and in localities

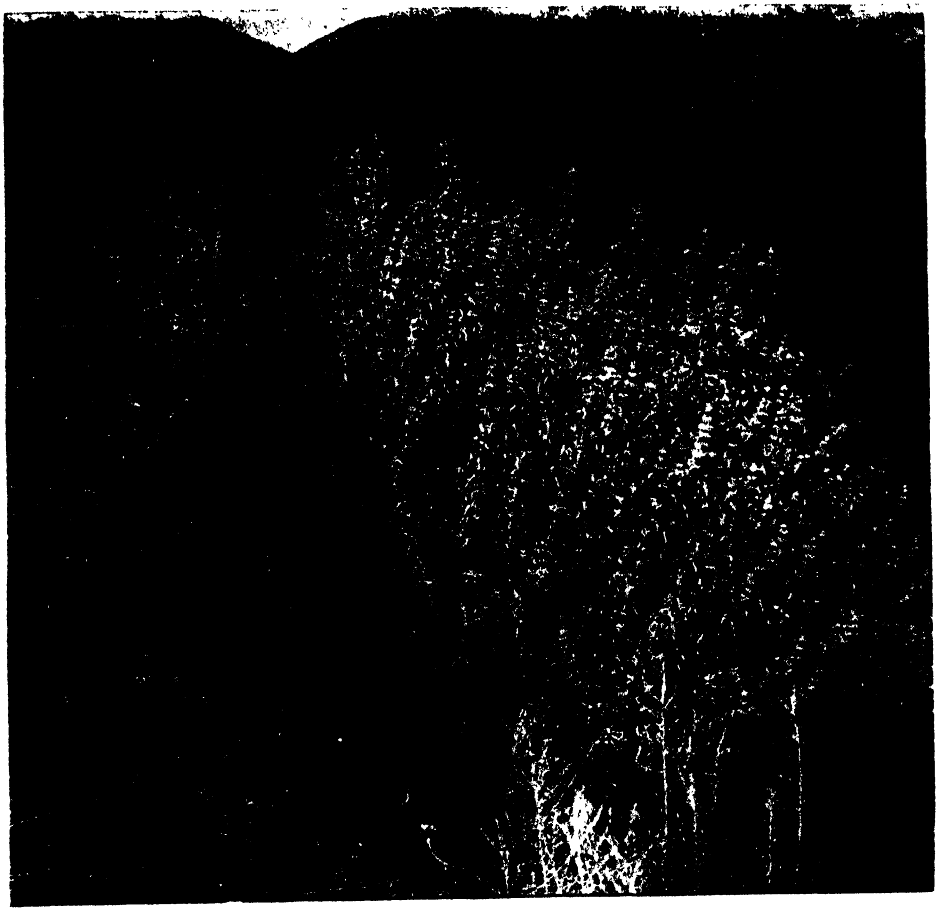


A stem of California black sage with blossoms.

in San Mateo County, practically the entire sage region of this state is restricted to the Coast Ranges extending from the foothills in the northern part of San Benito and Monterey counties to San Diego County in the southwest corner. The largest amount of sage honey comes from Ventura and San Diego counties, while a somewhat less surplus relatively is secured in Riverside and San Bernardino counties.

The three species most valuable as honey plants in California are black sage, white sage, and purple sage. Black sage is so called because the foliage is a very dark green, and also because the flowers after blooming turn black and adhere to the bush until the next season. From the mountain side the general color effect of the shrub is black. Purple sage has purple blossoms and the foliage has a grayish-purple appearance on the hillsides. When the two shrubs are seen side by side in the distance on the foothills, the contrast is very marked, the one looking dark or black and the other purple. The foliage of the white sage is grayish white and the flowers are also white. The black and purple sages are bushy shrubs very leafy at base, but the white sage has longer stems and is less bushy. The purple sage is much larger than the black sage and is sometimes six feet tall. The white sage grows on the flat mesa lands, while the black and purple sage are abundant on the foothills and the sunny slopes of the canyons.

The sage flow lasts from the middle of March or the first of April until about the first of July. The crop is unreliable every other year, and there is a total failure sometimes several years in succession. The black and purple sage does not yield nectar freely unless there has been at least ten inches of rain during the winter, followed by a clear warm spring. The rainfall varies greatly in different years, presenting great extremes, but frequently it is less than 12 inches. Although the plants are well adapted to live in



A bush of the California purple sage.

semi-arid regions, if there is a drought they dry up and become valueless to the beekeeper. The flowers are often injured by the sage worm and the foliage by rust. The honey is water-white, thick and heavy, and does not granulate.

The white sage secretes much less nectar than does either the black or purple sage. In districts where both the black and white sages are abundant beekeepers have estimated that the black yielded ten pounds of honey to one from the white species. To produce a vigorous growth and a profusion of flowers there must be a sufficient rainfall. Unlike black and purple sage, the true white sage honey will granulate and its flavor is not equal to that from black and purple sage. See "Honey Plants of North America."

SCALE HIVE.—Many of the most prominent beekeepers have in their yards, during the season when honey is coming in, a sort of barometer of the daily honey flow, or more exactly, a scale hive. This consists of a hive mounted on ordinary platform spring scales with a dial to indicate any increase or decrease in the weight of the colony. As the honey flow begins, it will be apparent that the hive will gain slightly in weight. This weight will increase during the day when there is a fair honey flow and decrease somewhat during the night, owing to evaporation of the nectar. As the season continues it is very easy to determine the strength of the honey flow, what days are best, what conditions are best for a honey flow, and when the season nears its close the dial will show a smaller and

Stems and blossoms of white sage.

smaller increase until no gain is shown at all.

For a scale hive it is advisable to select a strong colony — one of the very best in the yard, because a medium or indifferent one might not show any increase in weight, while the stronger colony would be able to record whether any honey at all were coming in. While, of course, it is understood that this strong colony is not a fair average of all the others in the apiary, it indicates to some extent, what the nectar secretion is in the field. If, for example, the best colony should record a pound or two pounds in a day, it might be assumed that the poorer or weaker colonies would show proportionately anywhere from a half to a full pound of nectar increase in weight. Again, the best colony on the scale might not show more than a quarter of a pound increase. Correspondingly the other colonies of the apiary might not show any gain if they were on the scale. Therefore, it is important to have the best colony in the yard. (See Comb Honey, to Produce.)

The scale hive is very useful in determining how far it is advisable to continue extracting in the yard. If the season is drawing toward a close and one desires to leave enough stores in the hive for winter, or to take care of brood-rearing in anticipation of another honey flow to follow in another month or six weeks, then obviously it is not advisable to extract if it would leave the hives without any stores, making it necessary later on to feed sugar syrup or put on a food-chamber.

The yield per day for a strong colony of bees may vary all the way from half a pound to twenty or even more pounds. Ten or more pounds would be considered

a good daily gain from clover, but more than double the amount is often gathered in a day by strong colonies from sage, orange blossoms, or other rapid yielders of nectar.

SCIENCE OF HONEY—See Honey, Science of.

SCOUTS PRECEDING SWARM.—See Absconding Swarms, also Swarming.

SECRETION OF NECTAR.— A knowledge of the factors influencing the secretion of nectar may assist the beekeeper in taking full advantage of the available supply and especially in choosing the best locations for his apiaries. It is often assumed that if plants are present in a region which is known to secrete nectar at times, they will assist the beekeeper in obtaining a good honey crop. This is an erroneous assumption, for almost any of the recognized honey plants fail, under some conditions, to produce nectar.

The honeybee is not native to America, and many of the plants on which the bees work are likewise imported to this country from other lands. It is interesting to note that at least half the marketable honey produced in the United States and Canada comes from imported species of plants, such as the clovers, buckwheat, alfalfa, and sweet clover. The chief honey sources of the southern states and of California are native plants. The imported plants which are so highly beneficial to the beekeeper do not secrete nectar freely throughout the range of their distribution. For example, white, alsike and sweet clovers are most important in the northern part of their range, and alfalfa does not yield as much nectar in the East as in the West. Secretion also does not occur throughout the entire blooming period of all these species. White clover rarely yields nectar heavily in late summer although it may bloom freely, and early buckwheat is usually not valuable.

Beekeeping has been especially developed in certain parts of the United States. The more important commercial regions are those parts of the white and sweet clover region where there is an adequate supply of lime in the soils, the irrigated regions of the intermountain country, the sage region of southern California, the buckwheat region on and adjacent to the Allegheny Plateau and certain rather limited areas of the Southwest. These regions appear at first glance to have little in common, yet it is seen that they are alike in having cool nights and warm days during the period of best nectar secretion. It then appears that this temperature condition is most favorable for the production of sugar in these plants, and for its secretion so that it may be gathered by the bees. These regions are also alike in that the time of the honey flow is relatively the same from the beginning of brood-rearing to the beginning of the honey flow, which indicates that approximately the same methods of management are applicable.

Great variation in the amount of nectar secreted during the various parts of the day have been noted. The most striking case is that of buckwheat, which usually secretes only in the mornings, but under changed conditions may secrete all day or only in the afternoons. For the majority of plants there is a decrease in the amount of nectar until about the middle of the afternoon, when the amount is least, followed by some increase toward the close of the day. This change may be due to higher temperatures at midday, or may be due to lowered relative humidity when the temperatures are highest. From these facts it appears that temperature is an important factor in secretion and that the daily range of temperature may be the important factor for some species. It is interesting to note that sugar production in maple trees, sugar cane and sugar beets also is greatest with a wide daily range of temperature. This offers some explanation for the fact that heavy nectar secretion rarely occurs along the seashore or near large lakes because of the decreased daily range of temperature in such situations.

The secretion of nectar is probably influenced strongly by the hours of sunshine. As one goes farther north, the length of day is greatly increased during the summer, thus affording the bees more hours for work and also providing the flowers with more sunshine for the elaboration of sugars. At any rate, it is noteworthy that the heaviest recorded amounts of nectar occur in far northern points, and in general the best secretion for any species of plant is usually at the extreme northern part of its range. This, of course, applies to the northern hemisphere, and probably the reverse is true for the southern hemisphere, although so

far no records are available on this point. Some of the best locations in the world for nectar are so far north that beekeeping is impossible because of the seriousness of the wintering problem.

Altitudes likewise have a marked effect on nectar secretion, and in general the heaviest secretions for any given species of plant occur at the highest altitudes for the plant. This is most notably true for alfalfa, the secretion at high altitudes being not only far heavier than at sea level but the nectar is far lighter in color and the resulting honey lighter and of better quality. Alfalfa is interesting in that it secretes nectar from below sea level (Imperial Valley) to regions a mile and a half above sea level, and the color and amount of daily gain change rather steadily throughout this range. The sages of California are also deeply influenced by altitude, but for these species another explanation is available. The sages range from sea level to an elevation of about 3000 feet and the secretion is, as a rule, heaviest at the higher elevations. Since rainfall is far more important for these species than any other known factor, it is interesting to note that the average annual rainfall steadily increases in the sage region with increased altitudes. The secretion of plant honeydews is also greatly increased at high elevations, so that in all probability some of the best beekeeping areas of the United States are so far inaccessible because of lack of roads to high elevations. The building of roads for scenic highways in the West promises to open up excellent beekeeping areas.

The Presence or Absence of Lime in the Soil a Factor in Nectar Secretion

The chemical composition and physical characteristics of the soil are important for many species of honey plants. White and alsike clovers are often said to be tolerant of soil acidity, and while they are often seen growing in soils that are acid or neutral, they rarely secrete nectar freely except in areas where there is considerable lime in the soil. This is clearly shown by mapping the areas where these plants supply nectar adequate for commercial beekeeping. It will at once be seen that the best development of beekeeping in the clover region is in those parts of the country where there is an adequate amount of lime in the soils. Sweet clover is a plant which seems to grow almost anywhere, yet as a secreter of nectar it is important only in areas where there is a high lime content in the soils, this plant evidently requiring more lime for full secretion than do white and alsike clover. Sweet clover is most important in the north-central states, in the irrigated region, with alfalfa, and in the Black Belt of the southern states, an area of high lime content. On the other hand, there are many honey plants which cease to produce nectar when there is much lime in the soil. Buckwheat seems to occupy an intermediate position, growing well on soils deficient in lime but secreting more nectar where there is a slight amount of lime present in the soils. The members of the heath family, including mountain laurel, clethra, the heathers of Europe, and other important nectar plants, thrive and secrete nectar only where there is a lack of lime. The physical characteristics of soils are also important. For example, sweet clover does best in the loessial soils of the Middle West, rather than in equally sweet soils with larger particles of lime in them in the North.

The effects of wind have been noted on many occasions by beekeepers, but as a rule these observations are not of general application. For example, some beekeepers of the white clover region maintain that an east wind is unfavorable for secretion from the clovers. The direction of the wind is chiefly valuable as an indication of pending storms, and probably the chief real effect of the wind is in drying up the nectar supply if the velocity is great. Changes in temperature are often also associated with the direction of the wind, and many beekeepers have noted that a south wind is favorable, usually accompanied by rising temperatures.

Many other climatic effects have an influence on nectar secretion, either immediately or later in the year. A heavy snowfall in winter is usually highly favorable to a good secretion from the clovers the following year by protecting plants from freezing and heaving. Heavy rains in late summer and fall are often beneficial in providing a heavy growth of the plants before going into winter condition. In the clover region the most marked effect comes from heavy rainfall in May, which stimulates the plants to heavy vegetative growth and gives them

a large supply of sugar for later secretion. Associated with heavy rains in May is the lack of good gathering days from the early minor sources.

SECTIONS.—See Comb Honey, Appliances for and Hives.

SELLING HONEY. — See Bottling Honey, Extracted Honey, Comb Honey, Marketing Honey, Shipping Cases, and Specialty in Bees.

SELF-SPACING FRAMES.—See Frames; also Frames, Self-spacing, and Hives.

SEPARATORS.—See Comb Honey, Appliances for.

SHADE FOR HIVES.—See Apiary.

SHAKEN (SHOOK) SWARMS.—See Artificial Swarming.

SHIPPING BEES.—Under Migratory Beekeeping mention is made of the advantage of moving bees from one locality to another to catch the honey flow. The practice has been extended so that bees are sometimes moved from one state to another in car lots. This enables the owner to gather two crops of honey; whereas if he were to remain in one locality he would secure only one. Under Package Bees is explained how bees can be sent by express without combs.

Theoretically, the movement of carloads of bees on combs in hives from the North to the South ought to be very profitable. As a matter of fact, dearly bought experience proves it too far otherwise. High freight rates coupled with loss of brood and bees make such shipments impossible. The rapid development of the package bee business has made it practicable to send bees in wire cages without combs or hives by express or truck very much cheaper. (See Package Bees.)

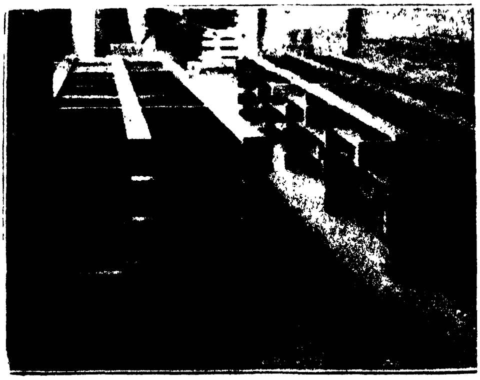
While the moving of bees in car lots from Florida to some northern state is attended with loss, it is possible to move bees from Idaho into California in car lots in the fall or early winter. (See Migratory Beekeeping.) The distance is much shorter and one is much more sure of catching a paying crop at either end of the route than he is when he moves a car to Florida and back to his own state in the North. Even then shipping bees in package form without combs, and having hives and combs at both points, would be cheaper in the long run. (See Package Bees.)

Moving by Truck

Where one desires to move only 100 or 150 miles and the roads are suitable, using a large traction motor truck, with a trailer, will be cheaper than sending by rail. Even though one has to pay at the rate of five or ten cents a mile the cost of moving will be less than moving by train. Usually a motor truck with a trailer can be secured that will move one or two hundred colonies at a trip. The cost of loading will be very much less, because when bees are shipped by rail they must be securely fastened to take care of the severe end jolts of a freight train that are heavy enough to jar every hive loose from its moorings and let the bees loose. The motor truck, on the other hand, will be under the direct control of the owner of the bees. It can start gradually, and be run slowly enough to avoid jolts and deliver the bees to the yard.

How to Prepare a Carload of Bees

Formerly it was thought necessary to build a series of shelving made of 4 x 4's and 2 x 4's to hold the hives one tier above another, as it was supposed that some colonies might need individual treatment en route. But experience shows that this is impracticable. Moreover, the arrangement of shelving wastes space, and makes the loading and unloading very difficult and expensive.

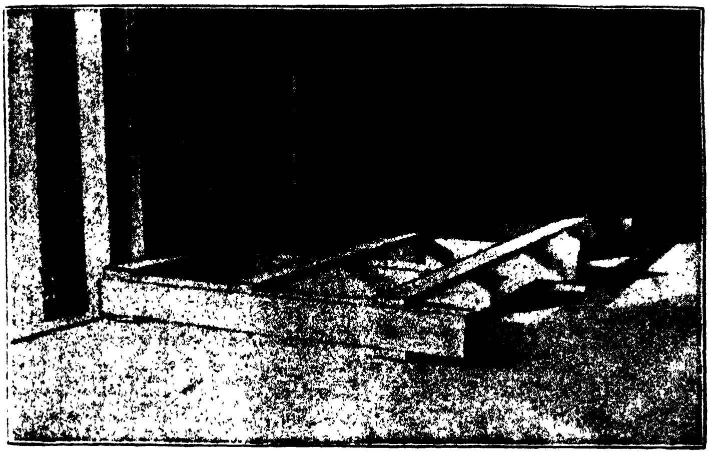


Crating to go between the tiers of hives.

A better plan is to provide a series of cratings made of 2 x 4's and long ⅞-inch strips 4 inches wide. The cratings

should be put together in such a way that the 2 x 4's stand on edge. For cool or cold weather they might be laid flatways and thus save a little room. The long strips are to be nailed on each side, making in all a framework 4 inches thick plus two ⅞-inch strips, or a total of 5¾ inches.

The illustrations show how the crating is put together. Each crate should be long enough to run from the car door to the end of the car, and wide enough to take the car is loaded in precisely the same way. When all are in place, the upright 2 x 4's as long as the height of four tiers are bolted to the projecting ends of the horizontal 2 x 4's in each crate. Bolts are used because they are more easily removed than nails and are stronger. Thus there is a set of two tiers of hives on each side of the car with an alleyway between these sets. The two sets are then braced from each other by means of ties across the top and bottom. To



One section in the car ready for the first row of hives.

two tiers of hives. The ⅞-inch strips are nailed one on each side and one in the center, from center to center equal to the width of the hive. The two-by-fours are spaced a distance equal to the length of the hive. A crate is set down on the car floor to provide bottom ventilation. Two rows of hives are piled on the crate side by side, lengthwise of the car, or so the combs are parallel with the rails of the track. If everything has been done right the edges of each hive will rest upon the long 4-inch strips. Every alternate 2 x 4 in the crate is made a little longer so that it can be bolted to an upright 2 x 4 that binds the four tiers of hives together. The operation of loading is as follows:

One crate is placed on the car floor. Two rows of hives with screens at top and bottom are loaded on the crate. In hot weather it is not advisable to try to get along with only a top screen. Over the first tier is then placed another crate; on top another tier of hives until there are four tiers. The other side of stand the end shocks the two sets of tiers in each end of the car are securely braced apart by 4 x 4's. These ties or braces must be at the top and bottom so that the operator can reach every colony with a watering pot.

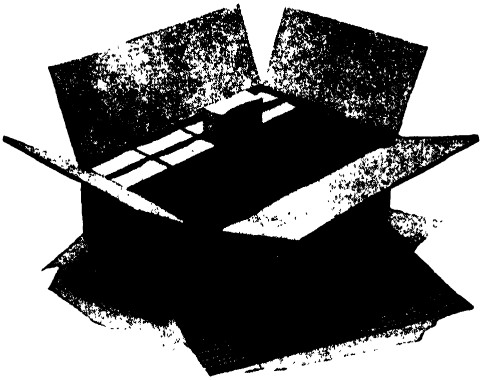
When a cattle-car is used the crates can be wired to the frame of the sides of the car. This helps to hold each tier to itself.

Spraying the Bees to Keep Them Cool

The operator should have room enough so he can go back and forth between the hives to sprinkle them with a watering-pot or force-pump. It is important to have in each car barrels of water along with a camp bed and tools. During hot weather on a trip bees will use considerable water en route. When the car stops and the weather is hot, bees will be thickly clustered over the wire cloth. To prevent their becoming overheated the wire cloth should be sprayed. Care should be taken not to overdo it, as the young brood will be chilled. As a general thing, unsealed brood, either on account of too

much heat or chilling in bad weather, will be killed, although shipments have been brought through with all the brood in good condition; but the weather was cool, and the hives were sprayed only when the car was not moving.

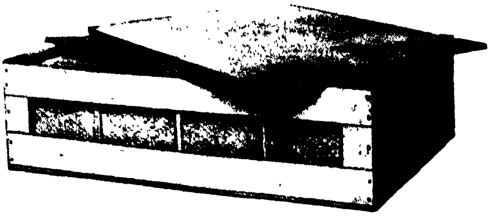
SHIPPING CASES.—One of the most beautiful products coming from the bee hive is comb honey. It is nature's product just as the bees produce it and when comb honey is properly displayed along with honey in glass, it makes a very attractive exhibit. Nothing is more difficult to ship than comb honey, not even eggs. Probably 95 per cent of it is put up in little wooden squares or sectional honey boxes. (See Comb Honey, pages 179 and 185.) The other 5 per cent represents honey cut up into squares and wrapped in cellophane, after which they are slipped into cartons of suitable size. (See pages 177 and 178.)



Single tier corrugated paper fiber case.

The comb honey with which we are concerned under this heading is that which is produced in sections. This product must be carefully packed in suitable cases in order to stand shipment for the market. There are two types of shipping cases: one made entirely of corrugated fiber or paper, and the other made of clean white wood with glass fronts and having at the top and bottom corrugated paper to cushion the honey while in shipment.

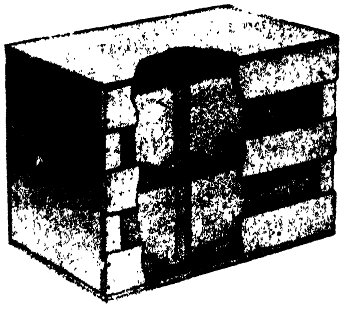
While the corrugated fiber cases made entirely of pasteboard or fiber board cost about half as much as those made of wood having glass fronts, the buyers as a rule, especially large buyers, prefer the wooden cases, not only because the honey can be properly displayed through the glass fronts, but because the wood makes a very much stronger case. Those of fiber should only be used when the producer delivers the honey in his own truck to market. If he ships it by express or by freight in large or small quantities, the combs are liable to break down in the



Single tier wooden shipping case with corrugated paper top and bottom.

sections; even if only one comb is broken, it will cause a leak that will run all through the case and the small saving affected in the cheaper case will be offset several times over by the loss of the honey. There is not only the broken comb itself, but all the other combs are badly soiled and must be repacked.

Generally speaking, comb honey should not be sent by express when packed only in fiber or wooden cases. It is found much safer to put the cases, either of fiber or of wood, in special carriers described further on. In the bottom of the carrier is placed loose straw to cushion the load. When the cases are made of wood and have glass fronts the freight handlers can see the fragile character of the contents and they are much more careful in handling the carrier as a whole. If, however, the honey is packed in fiber cases so that it can not be seen, the railroad people are more careless in lifting and handling the carriers.

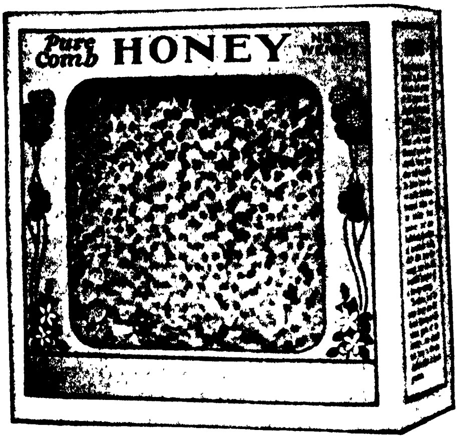


Double wooden shipping case with glass front and corrugated paper top and bottom.

It is generally believed that a double tier comb honey wooden case will stand rough handling better than any other case, either single tier wood or fiber. The

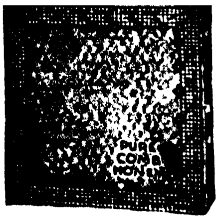
reason is that the double tier is more nearly that of a cube and therefore the box is much more rigid than if it is relatively shallow as in the single tier. In case of comb honey in 4 x 5 sections, it is generally conceded that the single tier case is better.

A good many honey producers believe it better to put all their comb honey in cartons, preferably those with transparent or cellophane front. These, when pack-



Window faced carton to hold and protect a section of honey.

ed in wooden cases, one dozen or two dozen to the case, are almost sure to go through in good order, providing other precautions are reasonably taken. When the cases arrive at destination the retailer can take them out of the case and place them on display at his store.



Cellophane wrapped comb honey.

There are a few who prefer the cellophane wrappers without any cartons. While the honey looks very nice in these, they do not ship as readily because the thin cellophane wrapper does not protect the section or its contents.

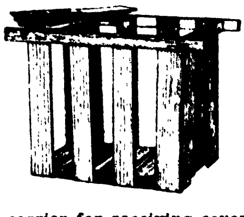
Home Made Cases

There are a few honey producers who have their shipping cases made at their local planing mills. No greater mistake could be made. The amount saved in the cost of the cases is more than made up several times over by breakage of the combs because the cases will never fit the sections as they should. The wood is generally of poor material, roughly sawn and inaccurate as to dimensions. If there is the least looseness in the case or if the cover and bottom fit too tight, the sections will be crushed and the honey broken down. It is always wiser and much safer to use the regular factory made cases, either fiber or wood with glass fronts, preferably the latter.

How to Ship Comb Honey

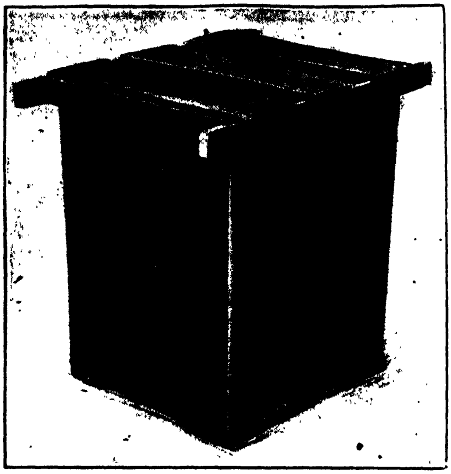
One may have his shipping-cases factory-made or ever so perfect, and yet have his fine comb honey shipped in them broken down. As a rule it is not advisable to send such a product by express, although it can be done. The experience of the publishers has shown that comb honey sent by freight goes through at less cost, and in much better condition.

Much will depend on whether comb honey is sent in car lots or in less than car-lot shipments. A single case of comb honey or half a dozen or a dozen of them can not be sent without being put into a special carrier or crate. No matter how modern the cases may be, with plenty of corrugated paper for top, bottom, sides and ends, if they are sent uncrated, either by freight or express, there is almost sure to be breakage and leakage of the comb honey. Where a customer wants a single case, or a couple of them, they should be put in a box large enough so that they can be well packed all around in straw. Comb honey is seldom shipped in lots of less than four to eight cases at a time, making an aggregate weight of not less than 100 pounds. The carrier or crates that are ordinarily used will take eight cases, or the equivalent weight of 200 pounds.



A crate or carrier for receiving several cases of comb honey.

The carrier here shown is lined on the inside with paper to conform to the rulings of the railroad companies. On the bottom is then placed six or eight inches of loose straw evenly distributed, when the cases are piled in, one on top of the other, until the carrier is level full, four single-tier cases deep, of 24 pounds each,



Comb honey carrier.

and two cases long. The paper is then neatly folded over, after which the cover boards are nailed in place as shown in the cut below.

The carrier shown is so big and heavy that it can not be picked up by the freight-handlers and dumped or thrown. The handles sticking out suggest the method for moving it, and that means two men to pick it up and carry it wheelbarrow fashion. Two can easily pick it up and move it from truck to car and from car to truck, and from truck to destination with perfect ease. Such a carrier will go either by freight or express — preferably by freight - - without breakage or leakage. If 500 or several thousand pounds of comb honey are to be shipped, carriers like those here shown should be used. While they entail some additional expense they insure safe delivery of the honey, save loss from breakage and leakage, and leave a pleased customer at the other end of the route.

In very many instances the beekeeper can and should carry his own comb honey with his own truck to his near-by towns and cities. On bad roads, in a common wagon with no springs, plenty of straw should be put in before loading the honey; but usually an automobile truck is provided with springs, which, in connection with pneumatic tires and careful driving, will insure safe delivery without any carriers or crates or straw in the bottom.

It sometimes happens that all the local markets in the towns near by, as well as the cities, are more than supplied with comb honey. In that case, less than carload shipments should be sent in carriers.

How to Ship Comb Honey in Car Lots

When sending honey in car lots the carriers are not needed. The railroad companies should furnish a strong serviceable car that will stand rough usage —one that has not been used for carrying phosphate, wool, or live stock. A wagonload of straw should be provided in advance. The floor should be swept out when the car is ready and straw piled on the floor of the car to the depth of six inches all over. The cases of comb honey should be neatly piled on the straw in the car, one on top of the other, and of even height, like cord wood leaving a clear space of at least a foot from each end of the car. It is important that the cases be piled snugly against each other, in such a way that the combs will be parallel with the track beneath. Any intervening space left on the sides next to the car should be filled in with crating, boards, or straw tightly wedged in. There's not a great deal of side movement in a car; but it is important to provide for a slight amount of it. The whole car should then be filled out with comb honey of an even depth until within a foot or 18 inches of each end. It is not advisable to pile the honey up higher than about eight cases single tier, or four cases double tier. The intervening space of 18 inches at each end of the car should be filled in with densely packed straw. This can not be packed in too snugly. The purpose of the straw is to provide against serious end shocks due to stopping or starting of the train. It sometimes happens that a car of comb honey is shot ahead on a switch; and unless a man is on top of the car at the brake the car may be jammed into an-

other car. It is, therefore, important to see that the spaces at the ends of the cases in the car are cushioned with tightly packed straw. To keep the straw from working up at each end, thus allowing end shock between the cases, boards should be put over the top of the straw and held down by cleats on each side of the car.

SHOOK SWARMING.—See Artificial Swarming.

SIZE OF FRAMES.—See Hives.

SKEP.—The term "skep" is often used by old-fashioned beekeepers to refer to a colony of bees in any kind of hive; but more properly it applies to box hives and straw skeps — the last named meaning basket in old English. In England and even in Europe the old straw skep is still used quite largely because lumber is expensive and straw cheap. The bees are allowed to build the combs just the same as mentioned under Box Hives, Transferring, and under Hives, Evolution of. On top of the flat-top type of skeps modern supers containing sections are sometimes used. The making of straw skeps for cottagers is quite a little business in itself, requiring a certain degree of skill and industry.

Straw skeps are not used in this country; and if it were not for the familiar pictures of "ye olden times" Americans would know but little about them. (See Box Hives.)

SMARTWEED.—See Heartsease.

SMELTER SMOKE DESTRUCTIVE TO BEES.—See Laws Relating to Bees.

SMOKE AND SMOKERS.—One can drive cattle and horses, and, to some extent even pigs, with a whip; but one who tries to control cross bees without smoke will find to his sorrow that all the rest of the animal kingdom are mild in comparison, especially so far as stubbornness and reckless fearlessness of consequences are concerned. One may kill them by thousands or may even burn them up with fire; but the death agonies of their comrades seem only to provoke them to new fury, and they rush to the combat with a relentlessness which can be compared to nothing better than a nest of yellow-jackets that have made up their minds to die, and to make all the mischief they possibly can before dying. It is here that the power of smoke comes in; and to one who is not conversant with its use it seems simply astonishing to see bees turn about and retreat in the most perfect dismay and fright, from the effects of a puff or two of smoke from a mere fragrant of rotten wood. What could beekeepers do with bees at times, were no such potent power as smoke known? (See Bee Behavior, page 73; also Anger of Bees.)

There have been various devices for directing smoke on the bees, such as a tin tube containing slow-burning fuel, with mouth-piece at one end, and a removable cap with a vent at the other end for the issuance of smoke. By blow-

Mr. A. van der Spiegel, Bergen, Switzerland, still keeps a few of his colonies in straw skeps.

HONEY HARVEST TIME IN HOLLAND.

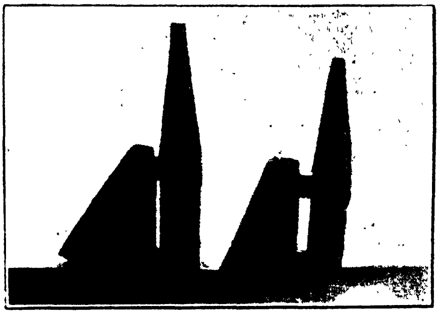
Upper—After killing the bees, the cross sticks are pulled out with pliers when the honey is ready to be dug out. Lower—Examining colonies previous to "taking them up." The heaviest, of course, are worth the most.

During a heavy honey flow holes are dug in the ground under straw skeps to give more room.

Bingham smoker, large size.

ing on the mouth-piece, smoke is forced out. Others, again, have used a tin pan in which was some burning rotten wood. This was put on the windward side of the hive so that smoke would be blown over the frames. All of these, however, were crude makeshifts in comparison with the bellows smokers which are on the market today.

Moses Quinby (in 1870) has the credit for first giving us a bellows bee-smoker. This was a decided step in advance over the old methods of introducing smoke among the bees. It combined the tin-tube idea with a bellows. In principle his original smoker did not differ essentially from the L. C. Root smoker, which was introduced later. It had, however, one serious defect; and that was, it would go out, the fire-pot not being properly ventilated to insure a good draft. Some years after, T. F. Bingham, L. C.



The original Quinby smoker.

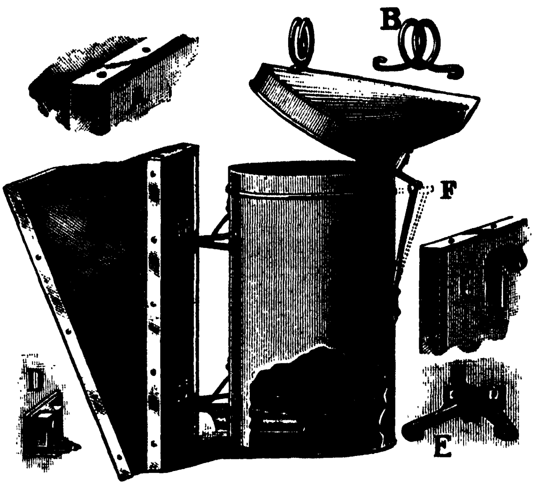
Root, son-in-law of Mr. Quinby, and A. I. Root introduced bee-smokers on the principle of the original Quinby bellows smoker, but with several decided improvements. The fire-cups, at the same time, were made rather larger, with a blast vent near the bottom. Through this vent a continuous draft could be maintained, even when the smoker was not in use, thus preventing them from going out like the original Quinby.

All of the smokers of today employ what is known as the hot-blast principle

—that is, the blast of air from the bellows is blown through the fire. This makes a heavy volume of smoke—volume enough, with the proper fuel, to subdue the crossest bees.

The improved Root smoker on the same principle, with its new snout, is very neat and substantial. The old-style nozzles were somewhat top-heavy, having a tendency to tip over or flop open at a most inconvenient time. The ones here shown are not only compact in appearance, but will hold their position on top of the fire cup without danger of toppling over no matter how roughly used.

The object of the deflected nozzle on all of the leading hot-blast smokers is to prevent fire from dropping. In the old-style smokers it was necessary in blowing smoke to tip the barrel almost upside down, or at such an angle that the fire-embers would sometimes fall on the brood-frames and the bees. The bent nozzle permits one to use the smoker right side up, and yet a stream of smoke can be poured on the combs.



Details of the Root smoker: A—Metal projection to aid the fingers in holding bellows; B—Coiled wire handle; C—Hook; D—Lock nuts for legs; E—Standard metal legs; F—Flexible hinge.

The Anti-spark Tube

There is another special feature in the Root smokers, and that is the anti-spark tube just below the grate. It likewise carries the blast of air from the hole opposite in the bellows to the fire-cup. As the end of the tube reaches to the center of the grate, sparks can not work backward, outward, and onto the clothing of the operator. This was a feature that was very troublesome in older types of smokers.

The flexible hinge makes it possible to fit the cap or snout on the cup more easily, as it allows a lateral movement.

Fuel for Smokers

It will be unnecessary to give instructions for using these smokers, as printed directions accompany all smokers sent out by the manufacturers; yet it may be well to allude to the different kinds of fuel that have been used. Rotten wood is good, and accessible to all, but it burns out too rapidly. Some recommend sound hard wood for the smoker. Others prefer turning-lathe hardwood shavings, or, if these are not available, planer shavings. In certain localities peat can be obtained very cheaply and it makes an excellent fuel. Some use old rags; others old discarded hive-quilts that are covered with propolis. These last make a very

Junior. Standard. Jumbo.
A. I. Root smokers.

pungent subduing smoke. In some parts of the South, dry pine needles are used.

Some use a special fuel made of old phosphate sacks rolled around a half-inch stick, tied at regular intervals, and then chopped into convenient lengths with a sharp ax. The rolls should, of course, be of the right diameter and length to fit inside the smoker. The sacking must not be rolled too tightly nor made to fit too snugly, or it will choke the draft and put out the fire.

To facilitate lighting with a match, one end of the roll is dipped half an inch into a solution of saltpeter, and allowed to dry. If a little red lead be sprinkled in the solution it will be very easy to tell which end of the roll is for lighting.

A quantity of old sacking sufficient for one season's use can easily be secured, as this fuel makes a lasting smoke without sparks.

Greasy Waste as a Smoker Fuel

The authors have been using greasy waste in smokers with great success. It requires no treatment with any chemical to make it light easily, and it is almost impossible to extinguish it after it is once lighted, even though it be stamped in the mud. This is perhaps the very best smoker fuel. It furnishes a strong subduing smoke, and is almost free from creosote. It can usually be had for the asking at any machine shop or garage.

Greasy waste is liable to take fire from spontaneous combustion. If used the supply should be stored in a metal receptacle away from buildings.

Abuses of a Smoker

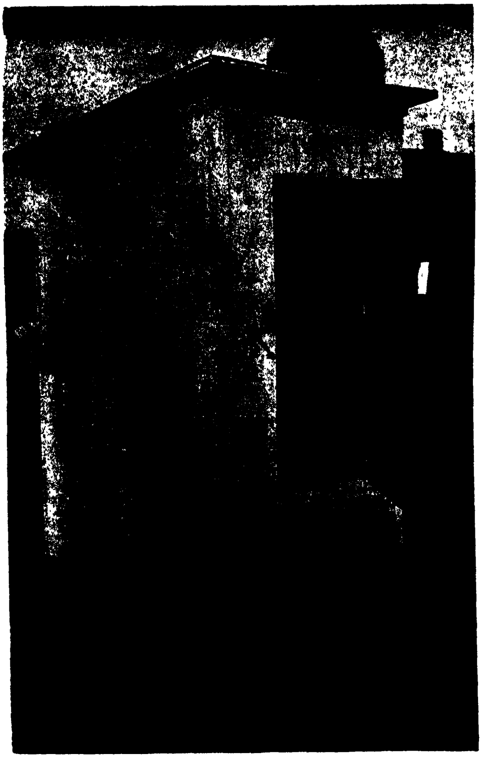
A good smoker should last a number of seasons, but it will very quickly cease to be a good implement if it is not well taken care of.

One of the most common abuses is to leave it out in the rain. Many smokers are left out in all kinds of weather; and it is needless to say that the bellows leather soon becomes hard and cracks, and the fire-box becomes rusty. Many beekeepers keep their smokers in an empty hive and thus avoid the danger of a costly fire. If the whole hive should burn, the loss would not be so very great.

A better plan than this is to build a small tool-house. This need not be over five or six feet high and two or three feet square. There should be a shelf, on which smokers, hive-tools, veils, etc., may be kept. It is a good plan to provide a piece of heavy sheet iron about half an inch above the shelf for the smokers to stand on, so that there will be no danger of setting fire to anything. The fuel is kept below this shelf. There is room enough usually to hold a supply for a whole season; and when it is kept in this way it is always dry and ready for use. The authors have such small buildings at all their outyards, and consider them almost indispensable.

Another common abuse of the smoker is to allow creosote to collect at the top until the cap will not fit down over the fire-box. In a new smoker with the flexible hinge there is not apt to be so much trouble in this way, but at the same time it is well to spend a couple of minutes once a week with a hive tool or screwdriver.

Sometimes beginners in their eagerness to test new smokers work the bellows so vigorously as to blow fire from the nozzle, and before they know it the fire-box is red-hot. This means, of course, that the tin is all burned off, leaving the bare



A tool-house for smokers and fuel. The latter is kept in the lower part under the shelf.

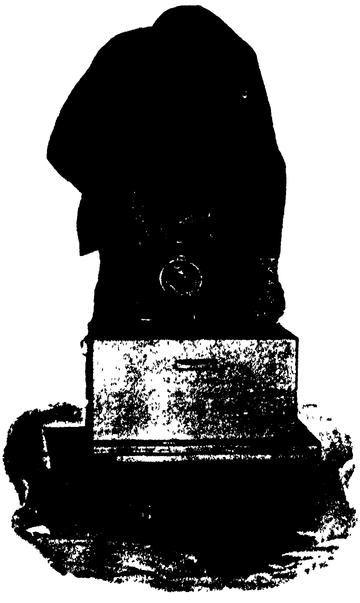
iron to rust through in a short time. There is no need of having a hot flame in the fire-box, for this implies perfect combustion. The secret of getting plenty of smoke is to have imperfect combustion. For this reason it is best to use fuels that burn slowly.

The grate will usually keep clean; but in some cases when it gets stopped up, insert the point of a file into one of the holes and lift it out. It can then be easily cleaned and replaced.

How to Use a Smoker

Perhaps the majority of beekeepers understand using a smoker without any special instructions, but, as a rule, too much smoke is used. It is best to use just as much as is necessary and no more. A beginner so often stupefies the bees that they appear completely overcome. It is needless to say that this is a very bad plan during a warm day. Very often during a warm day colony after colony can be opened without the use of smoke, especially when the bees are working; but at the same time it is well to have a smoker near at hand.

It is not considered good practice to smoke bees out of comb-honey supers, as they are frightened at the smell of smoke, and, in their desire to save honey, uncap some of the cells and thus spoil the appearance of what might otherwise be fancy honey.



Holding the smoker between the knees. Very often the knees can hold the bellows of the smoker if the bees are cross. It is thus ready for action in an instant.

In looking for a queen, use as little smoke as possible, as it is very easy to set the bees running over the combs, making it next to impossible to locate her. At such times the frames should be handled rather slowly and carefully, the beekeeper doing nothing to disturb or excite the bees. See last part of A B C of Beekeeping and Manipulation of Colonies.

How to Fill the Smoker

The most natural way of holding the smoker when the cap is opened is to hold the bellows in the left hand. A better hold is secured if the bellows is compressed. Take hold of the coiled-wire handle with the right hand when the cap can be raised very easily without danger of burning the fingers. This wire handle remains cool, no matter how hot the fire is.

SOLAR WAX-EXTRACTOR. — See Wax, also Bottling Honey.

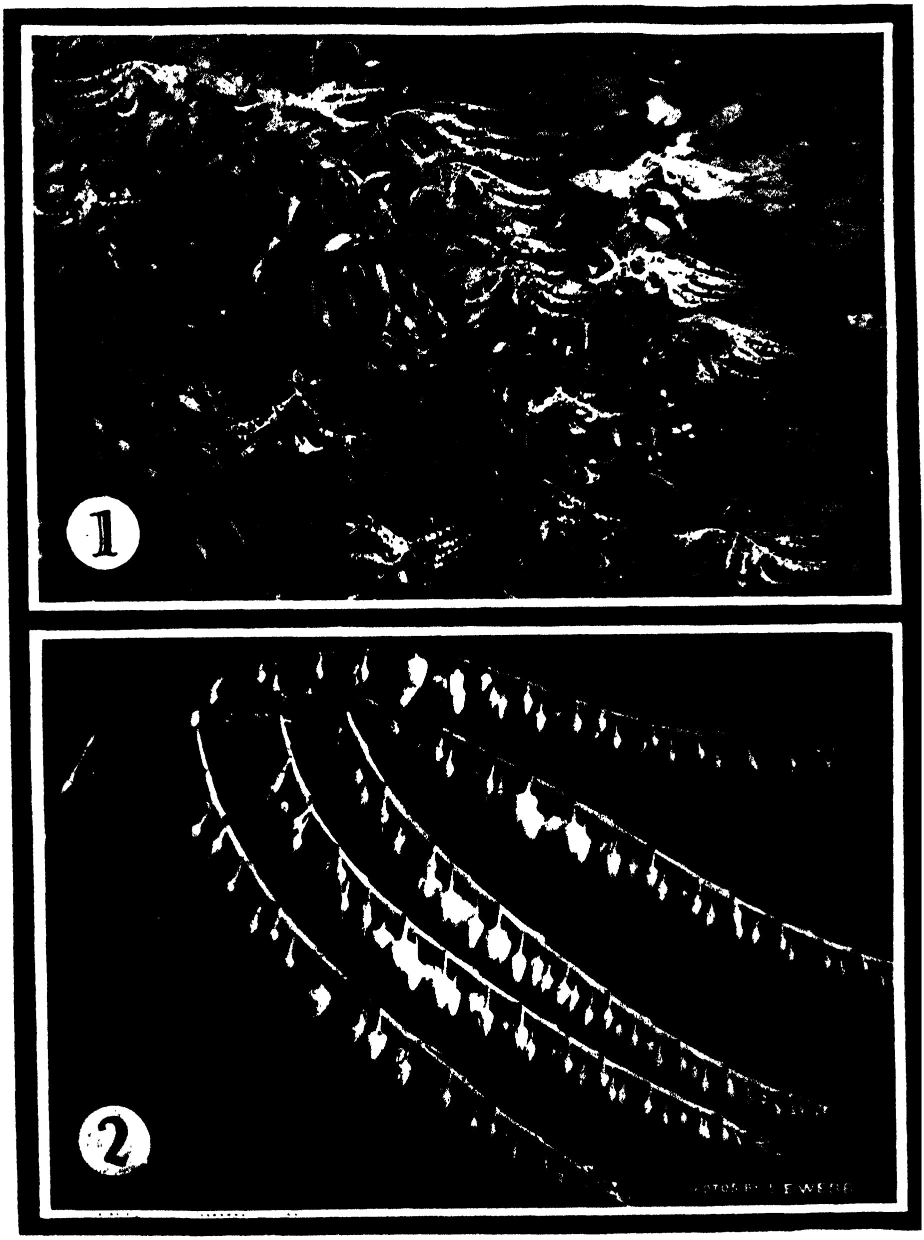
SOURWOOD (*Oxydendrum arboreum*). —Also called sour gum, sorrel tree, lily-of-the- valley tree, and elk tree. A fine tree growing 40 to 60 feet tall and a foot in diameter. The smooth bark is brownish red and the young twigs are light green.

Sourwood grows in rich woods from southern Pennsylvania to western Florida and southern Alabama, westward to southern Indiana, the Arkansas Mountains, and western Louisiana. It is most abundant in the mountainous tract of country occupied by the Alleghenies and the Blue Ridge, but it extends eastward in places as far as tidewater and westward to central Tennessee. On the Piedmont Plateau in North Carolina it is frequently a scraggy tree not exceeding 30 feet in height. In the dense forests the trunk is tall and unbranched, and furnishes fine straight-grained lumber used by cabinet-makers.

Sourwood in the mountains of North Carolina is in bloom for about two weeks during the month of July. The urn-shaped corolla is pendulous and contracted at the mouth, so that the bountiful supply of nectar is protected both from rain and useless insects. The nectar is secreted in such abundance that it may be shaken in small drops from the bloom. The honey flow is usually dependable; and in localities where it is abundant the beekeeper seldom misses a harvest. Al-

though, compared with some other honey plants, the season is short, there is no difficulty in securing a profitable crop. From 50 to 100 pounds of surplus is not infrequently stored by a single colony. In northwest North Carolina the surplus comes largely from this source, and the flow is reliable three years in five. As the honey flow comes so late, the beekeeper has ample opportunity to build up strong colonies which can gather nectar very rapidly during the short honey flow.

Under favorable conditions, sourwood honey is produced in enormous quantities,



Sourwood (Oxydendrum arboreum). 1, sourwood bloom in the forest; 2,, a single flower-cluster. Photographed by L. B. Webb.

but it is seldom found in the markets outside of the region in which it is gathered. It is regarded as one of the finest-flavored honeys in the United States and often commands in local markets a premium of a few cents per pound. The honey is white or light colored, with a delicious, slightly aromatic flavor, and is very slow to granulate. It is, however, often mixed with basswood honey, or with persimmon honey gathered early in the season. See "Honey Plants of North America."

SPACING FRAMES.—In nature, combs will be found spaced 1⅜, 1½, 1⅝, and sometimes up to two inches from center to center. Dzierzon, one of the very first to conceive the idea of a movable comb, gave 1½ as the right distance until Wyprecht made accurate measurements in straw hives having straight combs built in them. Out of 49 measurements, the average distance was scant 1⅜ inches. Baron von Berlepsch, by 40 other measurements, verified this result.

The author has measured the combs in hundreds of box hives in the Southland, and he finds that the average spacing for worker brood comb seems to be slightly under 1⅜ inches. The store combs run

The inside of a box hive after the bees have been drummed out. Notice how irregularly the bees have spaced the combs and wider at the top.

all the way from 1½ to 1¾, and even 2 inches. In a large number of cases it was noticed that the combs were spaced wider apart at the top of the box or comb and closer together toward the center and the bottom. The illustration shows a tendency that way, but it is not so pronounced as a number of others that were seen.

For worker brood it was apparent that nature indicates 1⅜ inches; for drone comb, 1½, although there are wide variations.

Hundreds of these measurements were taken on colonies that were being transferred; and if nature were to be followed it would seem that 1⅜ is the correct average for worker comb, and 1½ for drone. Store combs may have a spacing of 2 inches or more from center to center.

The beekeeper should adopt that spacing which will give him the best results —the most brood and surplus honey. A large number of beekeepers are using 1½ spacing for their frames. The reason for this is, principally, because they happened to start with this spacing.

Brood comb is found to be, on an average, ⅞ inch thick; capped brood, one inch thick. On 1⅜ spacing, this will allow ½ inch between uncapped combs and ⅜ between combs of capped brood.

Where wider spacing is adopted, there is apt to be more honey stored in the combs and less of worker but more drone brood. Close spacing, 1⅜, on the contrary, tends to encourage the rearing of more worker brood, the exclusion of drone brood, and the storage of less honey below. This is important.

C. P. Dadant, of the "American Bee Journal," believes that 1½-inch spacing tends to reduce swarming, and that the regular 1⅜-spacing is too close. On the other hand, it may be said that the self-spacing Hoffman frame adapted to 1⅜-inch spacing will gradually, on account of propolis accumulations, increase to 1½-inch.

For further information on the spacing of frames see Frames, Self-spacing; Hive-making; Hives; Honeycomb. On the spacing of combs see Skeps.

SPANISH NEEDLES (*Bidens aristosa*).—The honey has a golden color, excellent flavor, and good body, weighing fully 12 pounds to the gallon. It is so thick that there is little water to evaporate, and the cells can be sealed soon after they are filled. This plant has showy large-rayed heads, and yields immense quantities of honey along the low bottom-lands of the Mississippi and Illinois rivers. It is found in swamps from Illinois to Louisiana, blooming from August to October, and yielding a honey which is superior to, or is unsurpassed by, that from any other fall flower.

There are many other species of *Bid-*

ens widely distributed throughout America, all of which are probably of more or less value to bees. The common beggarticks (*Bidens frondosa*) is one of the most abundant. They are all fall flowers, and usually grow in wet places—one species being aquatic.

SPECIALTY IN BEES.—The question of making beekeeping a side line or hobby has already been pretty thoroughly discussed under the head of Beginning with Bees, Back-lot Beekeeping, Beekeeping for Women, Bees and Fruit-growing, Bees and Poultry, and Farmer Beekeepers. Under this head, "Specialty in Bees," will be discussed the feasibility of making bees the sole means of livelihood.

There are farmers who produce potatoes only. Others grow small fruits; still others, onions and celery. In the line of professions there are physicians who make a specialty of the eyes, some of the ears, and others both of the eyes and ears. Others give their whole time to the treatment of the lungs or the throat, and others to diseases of the skin. Some beekeepers specialize on queen-rearing and others on extracted honey. The number who confine their attention solely to the keeping of bees, while not large, is growing at a rapid rate.

Whether one shall keep more bees and drop all other pursuits will depend on a good many conditions. First is the question of locality; second, the man; third, the state of his finances.

Locality

No one should attempt to make a living entirely from bees unless he has a locality that is capable of supporting a large number of colonies. (See Locality and Overstocking.) In some places probably not more than twenty-five or fifty colonies could be maintained in one yard. Two hundred parceled out in five or ten apiaries two miles apart would increase the expense of operation. To put a man at each yard would be out of the question. An automobile truck is expensive. If one has a locality that will support five hundred to a thousand colonies in from ten to twenty yards, the gross earnings would warrant the purchase of an automobile truck and a runabout, perhaps, for making quick trips. (See Moving Bees and Out-apiaries.) As a rule, a few bees as a sideline can be kept profitably almost anywhere. However, if any one has a notion of making beekeeping an exclusive business he should seek some locality where there is an abundance of flora capable of furnishing a table honey that will bring a fair price, and a locality which, at the same time, is not already occupied by other beekeepers, thus overstocking. (See Overstocking.)

The Question of the Man

Some men who do well with a small business would make a failure with a large one. Going into beekeeping extensively requires not only capital and brains but a large amount of business ability. With the element of business ability comes the question of experience. Certainly no one should engage in the bee business in an extensive way unless he has a large amount of practical knowledge of a kind that starts from the bottom and works upward. (See Beginning with Bees; also Back-lot Beekeeping.) A large business gradually built up from a small beginning is much more sure of success, especially if the man who made the start is still the presiding genius of the large business. While one can sometimes hire a man of wide experience, it is better for the boss to have the "know-how" himself; otherwise, if his man leaves him for any cause he would be sadly crippled. (See Profits in Bees.)

Capital

Capital is another important requisite. This need not, however, be a serious obstacle if one would be willing to start with a small beginning and make the bees pay their own way, as is taught all through this work. One will be much more likely to meet with success if he gradually enlarges his business, bearing in mind the danger of trying to expand too fast.

Specialist Beekeepers; Where Located

The number of persons who make beekeeping a specialty is constantly increasing; but most of the specialist beekeepers are located west of the Mississippi and north of the Ohio. In the Rocky Mountains, where alfalfa and sweet clover are grown extensively, there are beekeepers who number their colonies by the thousand. The mountain-sage and orange districts of California make specialized beekeeping a possibility. Sweet clover districts in the East as well as the West offer opportunities for beekeeping in a large way.

As a general proposition, however, it

may be stated that where there is one specialist beekeeper there are a thousand who combine the business of honey production with some other profession or business.

SPECIFIC GRAVITY OF HONEY.—See Honey, Specific Gravity of.

SPIKEWEED (*Centromadia pungens*).—A branching annual with spinescent sweet-scented leaves. The yellow flowers yield an amber-colored honey of good quality, which granulates quickly. Carloads of spikeweed honey have been shipped from Fresno County, California. Jepson describes spikeweed as "abundant on the plains of the lower San Joaquin, southward to southern California and westward to Walnut Creek and Alameda. On the alkaline plains of the upper San Joaquin this species covers tens of thousands of acres, and often form thickets 4 or 5 feet high." It is also abundant in more or less alkaline land on the plains of Solano County. It is a valued bee plant. See "Honey Plants of North America."

SPRAYING FRUIT TREES. — See Fruit Blossoms.

SPRAYING DESTRUCTIVE TO THE BROOD.—See Fruit Blossoms.

SPREADING BROOD.—As is very well known, queens are inclined to lay their eggs in circles in the comb, the circle being larger in the center combs and smaller in the outside ones. The whole bulk of eggs and brood in several combs thus forms practically a sphere which the bees are able to cover and keep warm. When the queen has formed this sphere of brood and eggs she curtails her egg-laying for the time being until enough brood emerges to increase the size of the cluster, when she will gradually enlarge the circles of brood to keep pace with the enlarged ball of bees.

Yet the queen very often is overcareful—that is, she errs on the safe side, so that when warm weather has fully set in she sometimes lays fewer eggs than she should in the judgment of the apiarist, and accordingly he inserts a frame of empty comb in the center of the brood-nest. In this comb the queen may commence laying at once to unite the two half circles of brood. More often she does not. In that case more harm than good has been done. If the queen does fill the first one given she will be likely, if the weather is not cold, to go into the second comb and fill it with eggs on both sides; for nice, clean empty cells are very tempting to her. In a word, this operation of inserting empty combs in the center of the brood-nest is called "spreading brood," its object being to increase the amount of brood, and thus insure a larger force of workers for the prospective harvest.

It should be borne in mind that the practice of spreading brood has been almost entirely abandoned, even by experienced beekeepers. When the queen has plenty of room somewhere in the brood-nest (and that "somewhere" should be outside the brood-cluster), both bees and queen will ordinarily rear as much brood as they can safely and profitably care for. Read the whole of Food-chamber, Supering and Building Up Colonies.

SPRING DWINDLING.—Unless there has been a very severe winter, spring dwindling is usually the result of ignorant or careless management. It is a malady confined to bees outdoors or those just set out of the cellar, and appears only in spring—hence the name. It was once supposed to be a disease; but it is now known to be only the natural result of a severe winter on a colony too weak or a normal one not protected to stand the cold. Gradually the individual members die off until the original bunch of bees is reduced to a few dozens.

This increasing death rate may be due to a low vitality on the part of old bees that are inclined to die off before spring, or it may be due to poor food or insufficient protection, or dysentery. (See Dysentery.) If it is caused by the first mentioned, it shows that the colony went into winter quarters with almost no young bees. The force representing the colony was made up of old bees whose length of days would naturally expire at the beginning of the spring, even under good or the best conditions; when the conditions are not favorable, naturally these old bees die off much the sooner.

On the other hand, if spring dwindling is due to dysentery, the condition of the colony in the fall previous, if it could be known, would probably show an insufficient protection, or a cluster too weak in the first place to stand even an ordi-

nary winter, to say nothing of one that is exceptionally cold. Under Dysentery it is shown that this disease, or malady, rather, is the result of cold and overfeeding. (See Temperature.)

A good flight in warm weather will enable the bees affected with dysentery, if the cluster is not too weak, to cleanse themselves and make a new start. In fact, continuous warm weather is a relief for spring dwindling. But, unfortunately, in many localities there will come a week or two of warm weather at which time bees will start brood-rearing. When a cold spell comes on the already greatly attenuated force attempts to cover its brood, with the result that both brood and bees die. A changeable condition of weather is hard on nuclei that are suffering from spring dwindling.

Spring dwindling caused by dysentery may be due to bad food; but in most cases it is caused by insufficient housing. (See Spring Management.)

Winter Dwindling in California

There is a form of spring dwindling, or perhaps more properly speaking, winter dwindling, that occurs in semi-tropical climates, particularly in California. It is similar to the kind of spring dwindling that one encounters in the northern states of the East. In California, Florida, and many of the southern states the bees can fly nearly every day in the year. The sources that furnish nectar and pollen entice the old bees out of the hive, some of which never get back on account of a sudden chilling of the atmosphere. These pollen sources also start breeding. It very often occurs that the emerging of the young bees does not keep pace with the old bees dying in the fields, with the result that the colonies become weaker and weaker, until a ten-frame colony will get down to about three frames of bees and little brood about the time that the first real honey flow comes on. In some localities in California the eucalyptus, furnishing both nectar and pollen, is thought by some to do more harm than good, in that it starts brood-rearing during midwinter and forces the old bees into the fields, many never returning, as explained. In most parts of California there is a severe change of temperature during midwinter from the middle hours of the day to two or three o'clock in the morning before daylight. These sudden drops in temperature cause a great deal of the brood to chill and at the same time hold back the queen.

Much of the winter in the semi-tropical states is similar to spring weather in the northern and eastern states. In general characteristics the winter dwindling in these states is almost precisely the same as spring dwindling, with this difference, that there is never any dysentery.

Lack of Pollen

There is another kind of winter dwindling that is due to an entire lack of pollen both in the hives and in the fields. When that condition occurs in semi-tropical climates the colony will dwindle very rapidly, even though there is plenty of honey in the hive. The remedy, of course, is to lay aside a set of combs containing pollen, when pollen is coming in freely, and put them in the hives during February or March, or earlier if necessary. (See Pollen, Artificial Substitutes for Pollen.)

Remedy for Spring Dwindling

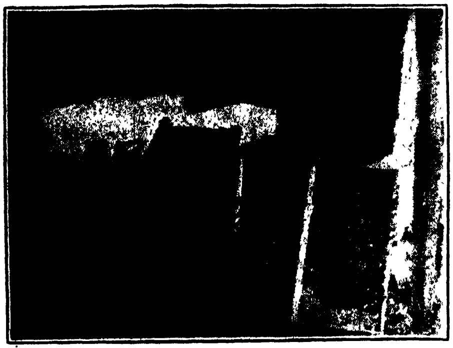
The real remedy is prevention. If the bees have been properly protected, given well-sealed honey the previous fall, and a young queen, there will not be much spring dwindling unless there has been a very long, severe, cold winter. In that case there may be an undue proportion of weak and dwindling colonies. The surest and safest way to bring them up to par is to give them each a two or three pound package of bees from the South. To unite weak nuclei from the same yard does little good unless the Alexander plan of uniting is used. (See Uniting.) Bees that have been exhausted by improper food or poor housing will die very shortly, even when four or five bunches of bees have been put together. After all, there is nothing that will do more good than a fresh infusion of young bees from the South. They will have vitality enough to clean up the combs and restore the morale of the wintered-over bees. Where there is already a good queen the package should be queenless. (See Package Bees, Food-chamber, and Spring Management.)

SPRING MANAGEMENT.—With the right sort of management throughout the season, every colony should be practically as good as the best. The efficient, up-to-the-minute dairyman would not think of tolerating scrub cows in his herd. He

would dispose of the undesirables and replace them with good stock in order to maintain a high average production. Likewise, the aggressive beekeeper is on the alert to detect failing or undesirable colonies of bees and to bring the subnormal colonies up to normal condition. Subnormal colonies are the result of faulty management as a rule.

Four Important Factors in Management

In the northern states the month of May is the most important of the year in apiary management. Brood-rearing in normal colonies is at its peak. A populous double-story colony should have the equivalent of 12 or 13 full standard combs of brood at the beginning of the main honey flow. All factors that enable colonies to reach their maximum strength at the beginning of the main honey flow should be present.

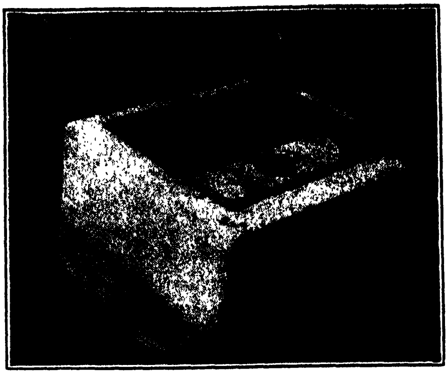


A strong two-story colony should have 12 frames well filled with brood at the beginning of the main honey flow.

The four important factors that the beekeeper can control are: ample stores, young queens, ample comb space, and protection. This pre-supposes that all of these requirements were provided the previous fall, and that, barring abnormal winter conditions each colony has reached spring in normal condition. There should be at least three pounds of bees in each hive at the time bees collect the first pollen in the spring.

What to Do With Weak Colonies

With the right sort of management the previous fall, weak colonies can be practically eliminated. However, an occasional queen may fizzle out during winter and early spring. Frequently a queen that appears to be normal the previous fall proves worthless early in the spring. Just why this occurs is not easy to explain, unless it is that there was some defect in the queen not apparent to the beekeeper.



A queenless package added to a weak colony at the right time results in a strong colony for the harvest.

In many cases weak colonies are due to a lack of stores. The queen in the weak colony may be normal. All she needs to make good is more bees to take care of the eggs she is capable of laying. A queenless two-pound package of bees united with each weak colony from five to eight weeks before the main honey flow

It is sometimes advisable to shake bees from extra strong colonies to unite with weak colonies.

starts will make the difference between success and failure in securing the maximum crops of honey. It is amazing how weak colonies will forge ahead after packages have been added.

To unite a queenless package with a weak colony, simply feed the queenless bees all the sugar syrup they will take by painting it on the screen of the shipping cage, then place the cage in the empty space in the hive close to the combs and remove the cover of the cage. Sugar syrup may be made by stirring two parts of sugar into one part of boiling water until all of the crystals are dissolved.

The Importance of Ample Stores

During the spring months, no colony should have less than 15 pounds of honey, or the equivalent of three full combs. Colonies that have been provided with food-chambers the previous fall are not likely to need feeding in the spring. When no combs of honey are available, a simple method of feeding consists of filling either a five- or ten-pound friction-top pail with warm sugar syrup, punch about a dozen holes in the cover of the pail with a three-penny nail, put on the cover and invert the pail of syrup over the hole in the inner cover. An empty hive-body should be placed under the cover to make room for the pail of syrup. If the hive does not have an inner cover simply invert the pail of syrup over the top-bars of the frames.

During the period of intense brood-rearing prior to the main honey flow, bees use an amazing amount of honey. It takes nearly a comb of honey to produce a comb of brood. Hence, the necessity of a superabundance of stores for each colony.

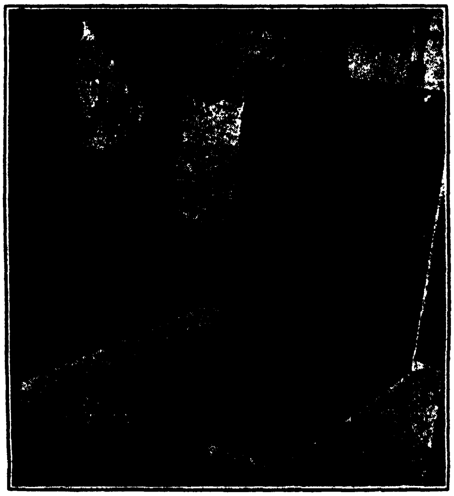
To obviate the necessity of feeding sugar syrup, reserve for each colony a food-chamber. This is either a shallow or deep super of early-gathered, well-ripened honey, in addition to what may be in the brood-chamber. This means wintering each colony in a two-story hive. This plan certainly simplifies apiary management and results in populous colonies for the honey flow.

Failing Queens

As already stated, some queens fail soon after they are introduced. Requeening is ordinarily done during July and August, but if a queen is found to be failing in the spring she should be replaced then. Any queen that lacks vitality, that is wobbly as she walks over the combs, greasy in appearance, and an indifferent layer, should be replaced with a young, prolific queen of a good honey-gathering strain. Directions for introducing the queen are on the under side of the card covering the cage.

Importance of Ample Super Room

Strong colonies must have ample comb space for brood rearing and the storage of incoming nectar or they will swarm. In the majority of localities in the North there is a spring honey flow from dandelion, fruit bloom, and other sources. Colonies in single-story hives frequently fill the combs with brood and nectar during this early honey flow. A super of combs should be given (without an excluder) to each single-story colony at the beginning of the early honey flow to avoid congestion. This will control swarming. It is frequently necessary to add a super of combs to each two-story colony during the fruit-bloom honey flow. It is safe to say that



An upper story full of honey supplies necessary stores for building up to great strength.

hundreds of swarms go to the woods each spring because supers are not added in time to avoid congestion within the brood chambers.

When we first began using food-chambers in our apiaries around Medina, we used to raise them up and place a super of drawn combs between the two stories, thus giving each queen the run of three sets of combs. Lifting up food-chambers means extra work which now seems unnecessary. At present, we set a queen-ex-

cluder on top of the food-chamber and place a super of combs on top of the queen-excluder, giving each queen the run of two sets of combs. If the queen needs more room, the honey will be carried up into the super on top.

In some regions where the early spring flow is heavy, colonies frequently store almost a super of honey. As there is usually an interval of dearth between the early and main flows, most of this unsealed honey will be used in brood rearing before the main honey flow starts. How simple it is, then, to furnish each colony with a super of drawn combs at the beginning of the fruit bloom honey flow, to make room for incoming nectar and brood rearing. If no drawn combs are available frames containing full sheets of foundation can be used.

There is another advantage in this method of supering in extracted honey production. When the major honey flow starts, each colony already has this super that was supplied during the early honey flow. This will hold them at the beginning of the main honey flow until more supers can be added.

Importance of Good Combs

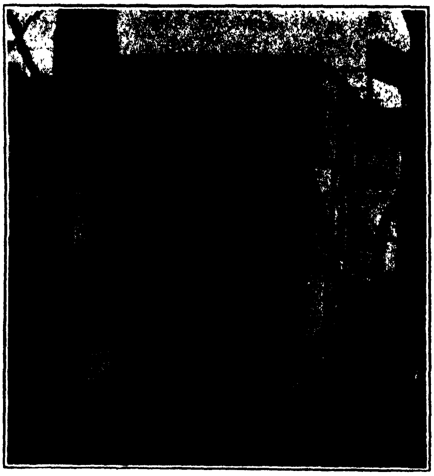
A perfectly good queen is often unable to do her best work because of the lack of good worker combs for brood rearing. As colonies are examined in the spring, poor combs consisting mainly of drone cells or stretched cells should be removed from the brood-chambers and replaced with good combs consisting of worker cells. A poor comb left near the center of the brood-chamber may hamper the work of a queen and practically cause suspension of egg-laying for a time, especially in early spring when the weather is too cold for the colony to expand its brood nest readily beyond the poor comb. Make sure that all combs in the brood-chambers are good worker combs.

The Importance of Pollen

In most regions pollen is plentiful in the spring. Sometimes, however, during long cold spells, when bees are unable to leave the hives, the supply of pollen runs low and bees are compelled to suspend or curtail brood rearing for a time. In two-story hives there should be a larger amount of pollen in the combs, carried over from the previous fall, than in single-story hives. In other words, 20 combs would likely contain more pollen than 10 combs. When ample pollen is available in the combs, brood rearing will continue in spite of cool weather. Some beekeepers worry about pollen-clogged combs in the fall. As a rule, all of this pollen is used up in brood rearing before the main honey flow starts the following season. (See Pollen.)

Early Spring Protection for Bees

Bees in their natural habitat are usually well protected against the elements. Ample protection during the cold chilly weather of spring is essential. No matter how good the queen may be, she can not lay to her full capacity unless the temperature of the hive is right. The correct temperature for brood rearing can be much more easily maintained in a well-



A double-walled hive with packed food chamber protects the brood during cold nights.

insulated hive. Winter packing should not be removed until settled warm weather comes. It is also important to select an apiary site well protected from the prevailing winter winds.

With all of the spring requirements kept clearly in mind when checking through the apiary, namely, good queens, ample stores, ample comb space consisting of good worker combs, the addition of queenless packages to strengthen any weak colonies, and the necessary protection against the chilly winds of spring, all colonies should be practically as good as the best and boiling over with bees raring to go when the major honey flow starts.

Dead Colonies in the Spring

In going over the yard in early spring one may find, if the bees are wintered

outdoors, one or more dead colonies. Their entrances should be shut up bee tight, for otherwise on the first warm flight day they will be robbed out by the other bees, resulting in a general disturbance of the whole yard. (See Robbing.) Combs on which bees have died may be used later on by putting fresh bees on them. Unless they are very badly soiled with dysentery so they are fairly smeared over with a brown excrement, or the stores are very bad, they can be used again. But badly soiled comb, or otherwise undesirable ones, should be put through the wax-extractor. (See Wax; also Dysentery.)

Entrances Clogged with Dead Bees

In early spring it may be necessary to rake out the dead bees in the entrances of some colonies. If a colony is strong it will usually do its own house-cleaning; but sometimes the dead accumulate in such numbers as actually to block the entrance. In all such cases there is danger that the few survivors may die outright. (See Entrances.)

STATISTICS CONCERNING THE BEE AND HONEY BUSINESS.—The United States Census for 1900, 1910, 1920 and 1930, includes bees and honey, but, unfortunately, its figures are limited to bees on farms of three acres or over, or farms of less acreage but which produce over $250 worth of agricultural products. Such a classification does not include a large number of small beekeepers living in towns, nor many of the largest commercial honey producers likewise living in towns, but whose annual production runs up into carloads. Obviously, those states having a large suburban population, such as New Jersey, for instance, would not be properly represented. For example, the census for 1920 credits this state with twelve thousand colonies of bees. According to E. G. Carr, former state apiarist and bee inspector, an actual count shortly following the 1920 census, showed over 36,000 colonies of bees, or three times as many as the census showed.

There were other like discrepancies for other states. For example, California was credited by the 1920 census as having only 180,719 colonies. A very accurate estimate based on reliable figures showed it had 325,000 colonies. A still greater discrepancy appeared in the case of Michigan and Ohio. With hardly an exception, the census figures were much too low.

An effort was made to get those in charge of the census to pursue a system for 1930 that would take in all the beekeepers, whether on farms or elsewhere. At that time the great depression was on when government expenditures had to be cut. The census people, while acknowledging that beekeepers were right in insisting that Uncle Sam's figures were wrong and misleading, regretted that for lack of funds they would be unable to comply with their request.

An appeal was then made to the Bureau of Agricultural Economics of the United States Department of Agriculture, Washington, D. C. This time we had not only a sympathetic ear but action. Harold J. Clay, Associate Marketing Specialist, the one who has for years been furnishing production and market prices on honey for beekeepers and the bee journals, was able to gather from reliable sources estimates which the author believes to be close to the facts. They are substantially in accord with those gathered by the publishers of this work from private sources. Here is the report and the table of figures covering the last five years that will speak for themselves. (See next page.)

The reader will note that the table shows the estimated number of colonies and the production of honey for each state covering the period of five years. At the bottom of each column is a total for each year for the whole United States, both of colonies and the amount of honey produced.

In the center columns are given colony averages for each state and for each of the five years. The average colony production for the whole of the United States covering the five years is arrived at by adding together the totals of the number of colonies for each year and the totals of honey production for each year and dividing the latter figure by the former. This gives the average colony production for the whole country as 36.6 pounds. Six years ago this average was placed at 50 pounds. This shows a falling off during the last five years of 13.4 pounds per colony. This may be explained on the ground that the beekeepers over the country have suffered a drouth ever since the depression started in 1929. While, of course, the drouth and the depression have no connection, it was an unfortunate coincident, for beekeepers especially.

In a general way, the total honey production for the last five years has mark-

U. S. DEPT. OF AGRICULTURE, BUREAU OF AGRICULTURAL ECONOMICS—ESTIMATED COLONIES AND YIELD OF HONEY BY STATES, 1929-1933.

The following tabulation has been compiled from estimates made by men considered among the best informed in their respective states, but which in most cases are based on incomplete data. It is believed, however, that they represent the best effort yet made to obtain such estimates for the entire country. In 2 states, marked with an *, even rough estimates could not be obtained, and the 1930 census figures, which are incomplete, were used.

States.	Estimated Number of Colonies.					Estimated yield (pounds)					1929	1930	1931	1932	1933
	1929	1930	1931	1932	1933	1929	1930	1931	1932	1933	pounds.	pounds.	pounds.	pounds.	pounds.
Alabama	150,000	138,000	138,000	138,000	138,000	6	10	35	10	10	900,000	1,380,000	4,830,000	1,380,000	1,380,000
Arizona	60,000	65,000	65,000	62,000	59,000	55	40	35	45	60	3,300,000	2,600,000	2,275,000	2,790,000	3,540,000
Arkansas†	120,000	80,000	80,000	80,000	50,000	30	15	16	16	15	3,600,000	1,200,000	1,280,000	1,280,000	750,000
California	375,000	375,000	375,000	365,000	360,000	41	41.1	38	48.3	36	15,375,000	15,426,000	14,318,000	17,612,000	12,960,000
Colorado	100,000	100,000	100,000	100,000	90,000	60	35	10	35	40	6,000,000	3,500,000	1,000,000	3,500,000	3,600,000
Connecticut	15,000	15,000	15,000	15,000	20,000	37.5	50	17	40	15	562,500	750,000	255,000	600,000	300,000
Delaware	2,100	2,170	2,250	2,300	2,275	25	5	50	100	10	52,500	10,850	112,500	230,000	22,750
Florida	100,000	150,000	150,000	125,000	125,000	30	50	10	8	15	3,000,000	7,500,000	1,500,000	1,000,000	1,875,000
Georgia	145,000	150,000	155,000	120,000	115,000	45	50	50	10	20	6,525,000	7,500,000	7,750,000	1,200,000	2,300,000
Idaho†	90,000	50,000	50,000	50,000	70,000	50	40	30	30	80	4,500,000	2,000,000	1,500,000	1,500,000	5,600,000
Illinois	350,000	300,000	275,000	300,000	275,000	50	20	30	25	30	17,500,000	6,000,000	8,250,000	7,500,000	8,250,000
Indiana	185,000	180,000	200,000	184,000	185,000	45	10	30	25	20	8,325,000	1,800,000	6,000,000	4,600,000	3,700,000
Iowa	200,000	200,000	185,000	180,000	170,000	80	70	50	55	50	16,000,000	14,000,000	9,250,000	9,900,000	8,500,000
Kansas	65,000	70,000	65,000	60,000	55,000	25	35	23	35	25	1,625,000	2,450,000	1,495,000	2,100,000	1,375,000
Kentucky	60,000	58,000	60,000	65,000	60,000	25	8.6	20	32	50	1,500,000	,500,000	1,200,000	2,080,000	3,000,000
Louisiana	115,000	120,000	120,000	120,000	120,000	40	50	50	40	40	4,600,000	6,000,000	6,000,000	4,800,000	4,800,000
Maine*	5,600	5,600	5,600	5,600	5,600	22.3	22.3	22.3	22.3	22.3	125,000	125,000	125,000	125,000	125,000
Maryland	18,000	18,000	18,000	18,000	20,000	25	15	40	60	18	450,000	270,000	720,000	1,080,000	360,000
Massachusetts	14,000	12,250	15,000	14,000	15,000	20	16	20	18	20	280,000	196,000	300,000	252,000	300,000
Michigan	215,000	215,000	200,000	220,000	225,000	75	55	20	70	60	16,125,000	11,825,000	4,000,000	15,400,000	13,500,000
Minnesota‡	100,000	100,000	100,000	100,000	100,000	70	70	70	70	70	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000
Mississippi	75,000	70,000	70,000	65,000	65,000	15	25	20	18	18	1,125,000	1,750,000	1,400,000	1,170,000	1,170,000
Missouri	150,000	100,000	100,000	125,000	150,000	35	12.5	12.5	25	30	5,250,000	1,250,000	1,250,000	3,125,000	4,500,000
Montana†	25,000	26,800	26,800	26,800	32,000	100	140	100	100	80	2,500,000	3,750,000	2,680,000	2,680,000	2,560,000
Nebraska	65,000	60,000	60,000	60,000	65,000	50	25	30	35	40	3,250,000	1,500,000	1,800,000	2,100,000	2,600,000
Nevada†	15,000	14,000	12,000	12,000	9,000	40	65	25	25	50	560,000	910,000	300,000	300,000	450,000
N. Hampshire§	4,500	5,000	5,000	4,000	4,000	12.5	15	20	15	15	50,000	75,000	100,000	60,000	60,000
New Jersey	40,000	41,000	40,000	40,000	40,000	40	20	42	20	20	1,600,000	820,000	1,680,000	800,000	800,000
New Mexico*	15,800	15,800	15,800	15,800	15,800	38	38	38	38	38	601,000	601,000	601,000	601,000	601,000
New York	200,000	200,000	210,000	210,000	210,000	37.5	42.5	42.5	40	30	7,500,000	8,500,000	8,925,000	8,400,000	6,300,000
North Carolina	235,000	235,000	240,000	240,000	212,000	30	28	30	28	28	7,050,000	6,580,000	7,200,000	6,720,000	5,936,000
North Dakota	32,000	32,000	32,000	35,000	35,000	132	85	108	104	92.5	4,224,000	2,720,000	3,456,000	3,640,000	3,237,500
Ohio	250,000	212,000	250,000	250,000	280,000	28	18.7	64.8	73.5	3.8	7,000,000	3,964,400	16,200,000	18,300,000	1,064,000
Oklahoma	49,000	45,000	35,000	32,000	33,000	40	30	20	20	20	1,960,000	1,350,000	700,000	640,000	660,000
Oregon	70,000	60,000	40,000	42,000	42,000	40	40	40	45	38	2,800,000	2,400,000	1,600,000	1,888,000	1,584,000
Pennsylvania	141,500	143,500	145,500	148,000	185,000	18	15	30	23	16	2,547,000	2,152,500	4,365,000	3,404,000	2,960,000
Rhode Island	2,700	2,900	2,500	2,650	2,750	24	21	25	27	26	64,800	60,900	62,500	71,550	71,500
South Carolina	20,000	40,000	30,000	30,000	30,000	25	25	25	15	55	500,000	1,000,000	750,000	450,000	1,100,000
South Dakota§	21,000	21,000	18,000	17,000	17,000	94	94	66	58	58	1,974,000	1,974,000	1,188,000	986,000	986,000
Tennessee	184,300	188,000	190,000	191,500	190,500	22	12	10	12	20	4,054,600	2,256,000	1,900,000	2,298,000	3,810,000
Texas	250,000	240,000	238,000	235,000	220,000	40	30	32	20	27	10,000,000	7,200,000	7,616,000	4,700,000	5,940,000
Utah	69,500	69,400	70,000	54,700	52,000	65	50	20	65	56	4,517,500	3,470,000	1,400,000	3,555,500	2,912,000
Vermont	10,000	10,000	10,000	9,000	9,000	40	40	50	30	20	400,000	400,000	500,000	270,000	180,000
Virginia	123,000	120,000	125,000	135,000	137,000	20	15	35	30	40	2,460,000	1,800,000	4,375,000	4,050,000	5,480,000
Washington	55,000	80,000	80,000	58,000	60,000	45	60	35	41	38	2,475,000	4,800,000	2,800,000	2,378,000	2,280,000
West Virginia	94,000	94,000	94,000	100,000	98,000	16	16	20	12	15	1,504,000	1,504,000	1,880,000	1,200,000	1,470,000
Wisconsin	167,000	165,000	148,000	145,000	130,000	114	71	35	40	40	19,038,000	11,715,000	5,197,500	5,800,000	5,200,000
Wyoming†	32,000	28,250	25,700	25,700	26,000	78	80	65	65	90	2,496,000	2,260,000	1,670,500	1,670,000	2,340,000
Totals	4,881,000	4,722,670	4,687,650	4,633,050	4,599,925						214,845,900	168,795,650	160,757,000	167,186,050	149,564,750

‡No estimates secured for 1930-32; 1929 figures used. †No estimates secured for 1932; 1931 figures used. *1930 census figures used. §No estimates secured for 1933; 1932 figures used. Average number of colonies per year, 4,704,850. Average production, 172,229,870 pounds.

edly fallen off as will be noted by consulting the table. In 1929, the total production of honey for the whole country was 214,845,900 pounds (or 5371 cars of 40,000 pounds each) as against 149,564,750 pounds (or 3739 cars of 40,000 pounds each) for 1933, or a falling off on account of drouth of 65,281,150 pounds. The showing in round numbers is a loss in production of honey for the whole country of over sixty-five million pounds. Measured by cars of 40,000 pounds each, it would make 1632 cars short of 1929.

These figures would be discouraging if the same ratio of loss in honey production should occur for the next five years. Fortunately nature seems to go by cycles. There will be a series of drouths followed by a series of wet or normal years. It is to be hoped that the next period will be more favorable.

The drouths have not been without their value. The farmers are putting in dry weather crops like sweet clover and alfalfa. By turning to Sweet Clover it will be noted that the onward march of sweet clover has been tremendous the country over, and where sweet clover grows there will be honey, and of a fine quality.

Why Large Yields from Some States

By consulting the table again it will be observed that certain states gave large yields of honey in spite of the drouth. Note particularly Ohio in 1932 with its 18,000,000 pounds of honey. In 1931 it had 16,000,000, or 450 and 400 cars respectively. But Ohio took a big slump in 1933 and again in 1934. Those were years when the drouth was too much for even sweet clover. It is significant, however, that in the northwestern part of the state, where there were early rains, there were the biggest crops of white and sweet clover on record. This was in 1934, when there was a big shortage of crops for the entire country.

With the exception of 1931, Michigan had large yields of honey every year. Michigan, it should be stated, during those years, had more rain than her sister states and wherever there was sweet clover there was a crop.

Wisconsin had a big crop in 1929 and a good one in 1930; but thereafter the yield began to fall off. This decline, as elsewhere, was due again to lack of rain.

Texas and California both show high average yields during all of the five years. It is not to be understood that they did not suffer from drouth. Quite to the contrary, the precipitation was light during the period. The reason for the relative large showing in honey production was due to their immense territory as compared with other states. Compare the production of little Rhode Island with either California or Texas.

See close of Foreword, at the beginning of this work, for some interesting figures.

Colony Averages for Each State

By consulting the middle columns in the table it will be noted that there is a great variation in colony averages for the different states. Several states are conspicuous by their high averages. Note particularly North Dakota, Montana, Wyoming and Colorado in the West. These high averages are due to sweet clover, lime in the soil, and to irrigation. If that honey-producing territory were relatively as large as in other states, it would excel all the other states in its aggregate amount of honey; but this honey territory is small.

Note again the high colony averages of Michigan, Wisconsin, Minnesota and Iowa among the middle western states. Here again the explanation is due to white and sweet clover with a high content of lime in the soil and to the high quality of the extension and bee inspection work in those states.

Figures for 1934

The author when he asked for the figures as given in the table, also inquired whether there were any figures available for 1934. Harold J. Clay, Associate Marketing Specialist for the Bureau of Agricultural Economics, writes under date, November. 8, 1934:

"I am sorry that I am not in a position to make estimates by states for 1934. We have a few 1934 figures already, but not enough on which to base a general estimate. There seems little doubt but that the crop this year is not only lower than that of 1933 but the lightest in many years, taking the country as a whole."

This opinion is supported as substantially correct by the bee journals, the bee supply manufacturers, and the bee inspectors.

The Rapid Development of Beekeeping in the Southern States

It is rather interesting to note the rapid development in beekeeping in the southern states. For example, North Car-

olina during the last few years has gone from the box- hive stage to the keeping of bees in modern hives. Already this state, as a comparison of figures will show, compares closely with the next state above it, and New York is one of the leading bee states. For this result no little credit is due to C. L. Sams, the bee extension agent for the State College at Raleigh. Georgia, like North Carolina, as the figures will show, comes next in line as a bee and honey state. Its colony averages are high as well as its aggregate production of honey. Florida, in the last few years, has made big strides in beekeeping. Its orange honey has become a very important crop. As the orange industry advances so will beekeeping. The two go well together. Like Georgia, it has a large list of honey plants, most of them yielding a fine table honey. If there are any states in the Union, especially in the South, that have a future for bees and beekeeping, they are Florida and Georgia. Florida's fine outlook for bees is due in no small part to the excellent bee inspection work done by R. E. Foster of the State Plant Board. Florida is probably more free from foulbrood than any state in the Union. (See Foulbrood.)

Louisiana and Texas, as the table will show, have made splendid progress in the development of the honey industry. Mississippi and Alabama have not distinguished themselves so much in the production of honey as they have in the production of package bees. (See Package Bees.)

More and more the northern beekeepers are going south for the winter. They pack their bees in the North outdoors and then go South for the winter to raise package bees to take back. They can live cheaper in the South than in the North, and at the same time get away from the cold.

Some Fallacies Corrected

There has been a belief more or less current that the West with its irrigation, sweet clover, alfalfa, mountain sage and orange, produces more honey than the East. It has been stated that the Rocky Mountain district alone could in a good year produce a thousand cars of honey. A careful comparison of the figures in the table by states will show that the first is a mistake. The East, as a matter of fact, if the estimates are anywhere near correct, and the author believes they are, far exceeds in annual honey production the production in the West.

The West may ship more cars of honey than the East because the West can not consume all its honey on account of the sparseness of its population. The East has a vastly greater number of people, can consume all its honey and then buy from the West.

Regarding the thousand cars of honey from the Rockies, the figures for the last five years do not support the statement. Most of the honey in the West must necessarily come from comparatively small areas in each of a few states. In these small areas there is more honey produced per square mile than in an equal area in the East. The principal reason why the East exceeds the West in honey production is because nearly all the territory in the Eastern states is capable of keeping bees and producing some honey. Quite the contrary is true in the Western States.

The Quality of Southern Honey

There is another fallacy not contradicted by the figures in the table, that southern honey is of inferior quality. Any one who has spent much time in any of the Southern States knows that this is not true. Most of the southern honey is consumed where produced. The southern people will not receive, much less eat, the very fine western sweet clover and alfalfa honey. There is, in fact, little or no western honey shipped into the southeastern states. The South much prefers its own.

Foreign Trade in Honey and Beeswax

According to data secured through the Bureau of Foreign and Domestic Commerce, a total of 3,036,424 pounds of honey was exported from the United States during the fiscal year ending June 30, 1932. This compares with a total of 4,005,587 pounds for the fiscal year ending June 30, 1931, and with a total of 4,183,122 pounds for the calendar year of 1931. Of the 3,036,424 pounds exported during the year ending June 30, 1932, the United Kingdom took 1,080,003; Germany, 754,380; Netherlands, 504,941; and France, 292,264. Only a few years ago, Germany was the largest importer of American honey, but recently that country has taken second place, leaving Great Britain far in the lead.

The exports of honey have been declining since 1929, the amount for the year ending June 30, 1929, being 11,805,816 pounds; for 1930, 6,471,770 pounds; for

1931, 4,005,587 pounds; and for 1932, 3,063,424 pounds. These figures are for the year ending June 30 in each case. During the fiscal year ending June 30, 1932, a total of 83,492 pounds were imported into the United States, and 2,900,-493 pounds were shipped to the States from Porto Rico and Hawaii.

The imports of beeswax into the United States during the fiscal year ending June 30, 1932, was 3,435,552 pounds, and 49,271 pounds were shipped from Porto Rico and Hawaii, making a total of 3,484,823 pounds as compared with a total of 3,867,-923 pounds for the year ending June 30, 1931, 4,295,859 for the year ending June 30, 1930, and 5,065,291 pounds for the fiscal year ending June 30, 1929.

Economic Aspects of the Bee Industry

A very interesting bulletin No. 555 has been sent out from the University of California entitled, "Economic Aspects of the Bee Industry." This records the results of a co-operative investigation conducted by the Pacific States Bee Culture Field Laboratory of the United States Department of Agriculture, Bureau of Entomology, and the California Agricultural Experiment Station. Nowhere in all bee literature is there such a compilation of interesting data and facts as are here given.

STINGLESS BEES.—See Bees, Stingless.

STINGS. — Many persons, doubtless, would keep bees were it not for the natural fear of stings; but when their habits are thoroughly understood this fear disappears. The average beekeeper pays no more attention to a sting or two received on his fingers than the mechanic who bruises his knuckles when a wrench slips. When bees are properly handled the number of stings can be reduced to a very low percentage. Very often one can work all day among his bees and not receive a single jab; and at other times, if he is a little careless, or if he takes chances, he may get a regular onslaught of a dozen at a time. When, however, one exercises ordinary precaution he will receive only on occasional sting; and even the effects of that, if he is quick enough, can be minimized to such an extent that it will be difficult for him to find it an hour afterward. The author once worked a whole month without a sting.

As will be pointed out later, the moment a sting is received it should be removed instantly—the sooner the better. If it is left in the wound it will gradually work itself into the flesh by muscular contraction, discharging the contents of the poison-sac, and the result will be far more severe than if it had been removed immediately, care being taken, of course, not to squeeze the poison-sac.

How to Avoid Being Stung

It is always advisable for the beginner to wear a bee-veil and a pair of gloves at the start. A good bee-smoker, with the fuel burning well, should be at hand. In cool weather, so far as conditions will permit, the time selected for handling the bees should be between 10 o'clock in the morning and 3 in the afternoon. In warm weather the operator should never stand in front of the entrance — always to one side. A little smoke should be blown in the entrance. The cover should next be lifted gently and more smoke blown between the cover and the hive before the hive is opened. More particulars in regard to opening the hive are given further on under this head; also under Manipulation of Colonies, subhead, How to Open a Hive, and in the last part of the A B C of Beekeeping.

Even after one does receive a sting he should go about his work as though nothing had happened. If he does not allow his mind to dwell upon the pain he will not find it so severe. If a sting is received through the clothing or a glove, it will be a mere prick, and can be instantly removed without getting very much of the effects of the poison.

Perhaps it may be urged that the pain of the sting could be endured provided there were no further swelling or disfigurement of the features. If one will wear a bee-veil carefully fitted to his clothing, there will not be very much excuse for having a swollen eye or a distorted lip. After one has been stung a certain number of times his system will become hardened or immune so there will be but little or no swelling. The average beekeeper can be stung on his face or hands a great many times; and beyond the mere pain for two or three minutes there will be no after-effects except a slight soreness for a few hours at the point where the sting was received. The number of stings that one must get before he becomes im-

mune depends somewhat on the individual himself. A very few never have any swelling, and others will become immune after a comparatively small number of stings. Usually in a season's operations one will become proof against swelling after a sting.

Too much emphasis can not be placed on the importance of removing the sting the moment it is given. This can be done by a quick rubbing or mashing motion, and very often one can parry or prevent a sting altogether by smashing the bee or brushing it off before it can get in its work. The bee, in order to sting, must take time enough to sink in its claws before it can force its weapon through the epidermis of its foe. At the precise instant that one feels the claws of a bee sinking into the skin he should dislodge it if he is in position to do so. Sometimes when he is holding a frame with a valuable queen on it he must "stand and take it"; but even then the frame can be set down gently and the sting removed. Usually, if there is just a mere prick of the skin there will be little or no swelling, and the pain will be hardly noticeable.

The Proper Way to Remove a Sting

With the blade of a knife, scrape the sting loose, being careful not to break it off nor to press on the poison-sac. A pressure on the latter will force the poison into the wound, making it much worse.

When a knife is not handy, push the sting out with the thumb or finger nail in much the same way. It is important to remove the sting as quickly as possible, for if the barbs (to be described further along) once get hooked into the flesh, muscular contraction will rapidly work the sting deeper and deeper. Sometimes the sting separates, leaving a part (one of the splinters) in the wound. It has been suggested that care should be taken to remove every one of these tiny points; but after trying many times to see what the effect would be, the author concludes that they do but little harm, and that the main thing is to remove the part containing the poison-sac before it has emptied itself into the wound. When very busy, or having something in the other hand to make it inconvenient to remove the sting with a knife or finger-nail, rub the sting out against the clothing, in such a way as to push the poison-bag sidewise; and although this plan often breaks off the sting so as to leave a part of it in the wound, there will be found little if any more trouble from it than usual.

Remedies for Bee Stings

Medicines of all kinds are of so little avail, if of any use at all, that the best way is to pay no attention to any of them. The author has tried a great many of them, but he has been forced to conclude that they were entirely futile. They not only did no good, but if the directions with the remedy were to rub it in the wound, they did positive harm. The friction would diffuse the poison more rapidly into the circulation, and make a painful swelling of what would have been very trifling if let alone. The poison is introduced into the flesh through a puncture so minute that the finest cambric needle could not, except by enlarging the puncture, enter the wound, and the flesh closes over so completely as to make it practically impossible for the remedy to penetrate the wound.

A Warning: Unnecessary Stings

Where one is operating several hundred colonies of bees, he may, in the height of the season, receive a dozen or more stings in a day and think nothing of it because he reasons that it is all in the day's work. He goes on the assumption that there is no permanent after-effects, at least he has so far received none. There may be none for a young vigorous man; but after one reaches middle life, particularly if his heart is not up to par, he should be warned that a large number of stings received at one time may cause a shock that may prove serious if the onslaught of stings is repeated on other days.

Every keeper of bees after he has passed his forties, particularly if he has reached sixty, should be warned that danger confronts him if he is of the belief that a dozen or more stings a day will do him no harm. He may be flirting with death. Shall he give up keeping bees? Not at all. In the first place, a good bee man knows that if he will take precautions to protect his hands and face, and use plenty of smoke at the right time, that he need not receive any stings. It is a poor beeman who works so bunglingly that he gets "all stung up" every time he works his bees. If he does not go out of business his poor old heart may put him out.

A good bee man, one who makes money from his bees, will usually pass a whole

season with but very few stings. He goes among his bees prepared. He wears the right kind of clothing. (See Veils.) He uses a good veil, preferably one of wire cloth, and when necessary, uses gloves. He takes no chances. He will select good weather when he can work all day without a sting, even unprotected. If one manages right he will not have to operate his bees when the weather is chilly and bad. There should be no opening of hives in late fall. Winter packing can be done without unnecessarily stirring up the bees. Smoke the entrances and then pack.

Dr. Beck, referred to elsewhere under this head, says that stings after a full meal have a more toxic effect than before a meal. He says:

> After meals the blood supply of the body is concentrated and monopolized by the gastric regions and the defensive apparatus is disturbed, especially when the blood supply is scanty or the propelling function unsatisfactory. Even if a person receives a larger amount of venom with hardly any symptoms that a real battle has taken place, the symptoms may be evident after the next meal, or even several days later, when the stomach demands its proper blood supply to which it is accustomed and "embarrasses" the defensive mechanism in the discharge of its function.

What To Do When Many Stings Are Received

A hot towel, wrung out of water as hot as can be borne and applied to the affected parts, will bring almost instant relief. If continuously applied in alternation with cold cloths it will do much to reduce the local fever and the swellng as well. One who is sensitive to a single sting, or one less sensitive but stung a good many times, should lie down and keep very quiet not only for that day but for several days, especially if he breaks out in blotches or feels shortness of breath. It is evident the heart is affected by the shock. A physician should be called and in the meantime the patient should be given a tepid bath and kept very quiet. If there is shortness of breath an electric fan blowing in the face of the patient will help much.

In the same way a hot blanket wrapped around a horse that has been badly stung will quiet the animal almost immediately. In either case the hot application should be continuously applied.

Fortunately, the cases of severe stinging are not common and the average person, if he uses a veil and gloves, need have no fear. He will soon become immune to the stings to the extent that there will be no swelling.

How One Who Is Seriously Affected by a Single Sting May Become Comparatively Immune to the Poison

There are a very few who are so seriously affected by the bee-sting poison that even a single sting will cause the body to break out in red blotches. Only one person in possibly ten thousand is thus affected. So rare are the reported cases that the editors of Gleanings in Bee Culture, a journal with a circulation of over 12,000, do not hear of them once in ten years. But there are quite a number of others who are less affected, but who aver that a single sting produces great discomfort. While there is little danger of loss of life, the results of a sting are such that they have been obliged to give up the delightful pastime of keeping bees, very much to their regret. All such persons were formerly advised when going among bees to be veiled and to wear gloves. But in late years a better plan has been found. It was suggested by the fact that the average person becomes less and less affected by the bee-sting poison. Inasmuch as the human system has the power to withstand increasing doses of many poisons, after the first one, why should it not be able to make itself immune to a certain extent against the venom of a bee-sting? It is a well-known fact that opium and morphine fiends are able to take doses of those drugs in amounts that would kill ten people who are not in the habit of taking them. The same thing is true of all alcoholic drinks. If one who is very seriously affected by bee-sting poison will just merely prick himself with a sting and then brush it off before it has had time to throw much of its virus into the wound, the aftereffects will not be very serious; again, if the dose is repeated some four or five days afterward, or about the time the effect of the previous sting has passed away, he can, by continuing this process, ultimately apply the dose at more frequent intervals until in time his system will be no more affected than that of an ordinary person.

An interesting case came under observation. A boy, when stung, became so affected that his body would break out in great red blotches; his breathing grew difficult, and his heart began to pound. It was really a question whether there was not danger of losing his life. Nevertheless, he was very desirous of engaging in

beekeeping, and determined to work with bees. A live bee was pressed on the back of his hand until it merely pierced his skin with the sting. It was removed immediately; and since no serious effect followed another single prick was administered inside of four or five days. This was continued for some three or four weeks, when the patient began to have a sort of itching sensation all over his body. The hypodermic injections of bee-sting poison were then discontinued. At the end of a month they were repeated at intervals of four or five days. Again after two or three weeks the itching sensation came on, but it was less pronounced. The patient was given a rest of about a month, when the doses were repeated as before. He then went away to school and was not back for eight or nine months. On his return the applications were given again, when it was plainly noticeable that the after-effects were becoming markedly less. He then went out into the bee-yard and was stung occasionally, but, beyond a small local swelling, there was no unpleasant effect.

Some months afterward he was assisting at one of the yards, when, without warning, a colony of bees that was being handled made a most furious attack on both the men. The young man who had been taking the immunizing doses of bee-virus received, he estimates, ten or a dozen stings all over his body. He had neither veil nor gloves, for the other man was doing the work with the bees. He expected serious consequences; but, greatly to his surprise and gratification, no unpleasant effects followed. What was more, there was no swelling. It should be remembered that this boy used to be so seriously affected that a single sting would cause his parents to worry, for they feared he would not be able to survive the shock. He now handles bees with the same freedom that any experienced beekeeper does.

Calling in a Physician

Dr. W. Ray Jones of Seattle, a beekeeper and a physician, the one who wrote the article on Honey, Sensitization of, tells how from a medical point of view to treat persons who have been severely stung.

For critical cases, treatment consists of frequent hypodermic injections of a one-to-one-thousand solution of epinephrine. The solution may be obtained from the druggist, or epinephrine tablets may be procured and kept at hand so that a fresh solution may be made very quickly if needed. Epinephrine (formerly known as adrenaline) is worthless unless given hypodermically.

The Nature of Bee Venom

The Division of Experimental Surgery and Pathology, Mayo Foundation, Rochester, Minnesota, published a paper on this subject in the American Journal of Physiology (1930) 94:209-214. The last two paragraphs of the paper are as follows:

"In general, the venom of the bee may be described as a violent endothelial poison and a marked stimulant of smooth muscle; it is comparable in these respects to histamine. In view of the fact that the perfused mammalian heart is promptly incapacitated by this substance and erythrocytes are quickly laked, it would be preferable to designate the venom as a general protoplasmic poison, as we have done for the venom of rattlesnakes.

"Occasionally following the intravenous injections of the venom of bees into a dog there is a preliminary rise in blood pressure. It is possible that some component other than the active principle of the venom is responsible for this initial rise. Apart from this observation, the venoms of the honeybee and of the rattlesnake apparently have similar physiologic properties. It is remarkable that the venom of the honeybee should be similar to that of the rattlesnakes. Wasps, hornets, scorpions, mosquitoes, nettles, and other forms, whose sting is followed by a similar reaction, possibly will be shown to possess venom with similar properties."

How to Avoid Being Stung

If the reader will turn to the A B C of Beekeeping, also Manipulation of Colonies, subhead, How to Open a Hive, and if he will read carefully the beginning of this article, he will have a general knowledge of how to avoid stings. It will be in order at this point to summarize and to amplify some things already said. The subject is so important that it can not be gone over too fully, even at the risk of repetition. Whether one will be able to make a success of beekeeping or not will depend very largely on how carefully he follows the directions given below.

1. He should have a good bee-smoker with the fuel well ignited. The author prefers greasy waste, which is procurable at almost any machine shop or garage,

and can usually be had for the asking. (See Smokers.)

2. He should have a bee-veil that is securely attached to the hat and to the waist or shirt. Those made of a special wire cloth are preferable to those made of fabric. (See Veils.)

3. His clothing should be loose, not fitting closely to the body; a blouse or shirt with sleeves buttoned or tied securely around the wrists should be worn. If he is shaking bees from the combs he should have his trousers stuck in his socks or folded around the ankles, holding them in place by means of strings. The shoes should be high enough to project under the trousers; and in the case of a woman the skirt should be long enough to reach the tops of the shoes. Or, better yet, let her wear a farmerette suit. Some of these suits are very neat and becoming. When bees are shaken on the ground care should be taken not to allow them to crawl up on the feet. If perchance they do get on the foot, it should be stamped on the ground, jarring them off. When the weather will permit, the man should have both his coat and vest off. A very good suit is that worn by garage men and railroad engineers in the form of a union overalls suit. Those who are very timid should wear gloves or gauntlets. (See Gloves; also Veils.)

4. One should never stand in front of a hive—always at one side or in the rear. When bees are flying back and forth from the hives to the fields they are more liable to sting, apparently working on the assumption that the obstruction has no business to be in the way.

5. A good hive-tool is important. In the absence of a special tool, a screwdriver or a knife with a strong blade may be used.

6. The middle hours of the day, if one is a beginner, should be selected for the manipulation of bees. The novice should never attempt to open a hive on a cool or chilly morning, or late in the afternoon, and never at night or after a chilly rain.

7. One should avoid opening a hive or going out into the apiary at a time immediately after a heavy rain or after any other cause that suddenly checks or stops the honey flow. Either a rain or a sudden drop in the temperature may stop the secretion of nectar. The more sudden the stoppage, the crosser will be the bees; and when they work on buckwheat or honey-dew they are apt to be cross when the flow stops along during the middle hours of the day, until it begins again during the afternoon.

8. Having selected a favorable time for the manipulation, the beginner should blow one or two puffs of smoke into the entrance of the hive. With a hive-tool, screwdriver, or knife, he should separate the cover from the hive by merely entering the blade, leaving a gap wide enough for the entrance of smoke, but narrow enough to prevent the exit of bees. A couple of puffs of smoke should be forced into the crack made by the hive-tool, after which the lid may be lifted and more smoke blown over the frames. The cover may be set down by the side of the hive. However, it is usually advisable to jar the bees from it by giving it a sharp blow on the ground just in front of the entrance, when they will quickly run in. This is important, because the crawling bees on the ground are quite liable to get on the feet and finally under the clothing; and a crawling bee always moves upward.

9. Before proceeding further the operator should carefully note the behavior of the bees. If they crowd up closely between the frames, making quick movements, and one or two start flying up as if about to attack, more smoke should be blown over the combs. If, however, a few of them crawl leisurely over the combs, apparently paying no attention to anything, the frames may be separated with a hive-tool or a screwdriver; but the smoker should be kept conveniently in the other hand; and if at any moment the bees show a disposition to rush out or sting more smoke should be used. On cool or chilly days, when the bees lift up their bodies and show their stings, look out.

10. If there is a division-board in the hive it should be removed. The frames should be separated on either side of the one that is to be taken out. If the operator or beginner is timid he should blow smoke over the tops of the frames, and then very quietly lift the frames selected, being careful to avoid jerks or quick movements, and especially careful not to roll the bees over when pulling it out. This can not be emphasized too strongly. Crushed or maimed bees may stir up

the colony to a fighting pitch. After the first comb is removed the others may be taken out very easily.

11. The operator should not only avoid mashing or killing bees, but he should never jerk the hands back, even if two or three bees do rush out and make a bluff as if they were about to sting, which they will seldom do. If the hand is held stationary when they make these onslaughts they will seldom sting; but if the hand is jerked backward it may be stung by two or three bees. Just the moment that a bee inserts its claws the hand should be withdrawn, and, when away from the hive, quickly rubbed against the clothing in such a way as to brush the bee off before it can sting.

12. One should learn to distinguish between bees that are angry and those that are flying about aimlessly. Cross bees will be detected by their high keynote and their quick darting movements in flight. A bee that nervously flits back and forth before the face, giving out a high keynote, is cross, and will sting unless the operator has his face protected by a veil. The best thing to do with such bees is to pay no attention to them, if protected.

13. When replacing the frames, they should be put back in the same order they were in originally, being careful not to pinch any bees.

14. Bees are much more inclined to sting during a time when there is a dearth of honey, or when robbing has been allowed to get started. (See Robbing.) One should not leave a hive open very long when stray bees from other hives are hovering over the tops of the combs, now and then darting into the hives or onto the combs, attempting to steal.

15. After the hive has been opened and has stood for a while without any manipulation, the frames left in the hive should receive two or three puffs of smoke before handling. This is to drive down the guards.

16. Hot breath from a human being or an animal when combs are handled very often starts bees to rushing off the combs by the dozen and alighting on the veil. If one has no face protection he may receive a dozen stings in the fraction of a second.

17. Bees are more apt to sting a man, or an animal, when he is sweaty and gives off a strong odor. However, the practical beekeeper pays but little attention to what his condition may be. His experiences will determine what to do if the bees show a disposition to be cross. At such times the smoker should always be ready. It is the indispensable implement in the yard, and should be in condition to give off a volume of smoke at any instant —not that one's life depends on it, but rather to save time and to avoid stings.

18. Children should not be allowed to race through a bee-yard when bees are busy in going to the field, or at any other time when they might be a little cross. They should be cautioned to go around the apiary. While the children of beekeepers sometimes become careless, they should avoid, as far as possible, doing anything that will cause unnecessary irritations to the bees, thereby provoking them to sting.

19. Never hitch a team or a horse near a hive of bees. A single sting will sometimes cause a horse to break loose, rush through the yard, knocking over hive after hive. If for any reason he becomes entangled in his harness he will be stung to death, and at the same time the life of the owner may be in danger in trying to save the animal. When hives are knocked over as the result of a runaway horse or team, there is liable to be a general stinging fracas. The owner should not be tempted to go into a yard at such times without veil and gloves, and a smoker well ignited. To do so without protection is only inviting disaster. Fortunately the automobile has in the more densely populated centers, taken the place of the horse.

What Kinds of Bees Sting Worst

The general decision now is, that pure Italians, Caucasians, and Carniolans are the most easily handled. (See Races of Bees.) Not only do they sting less, but, as they keep their places on the combs without getting excited when the hives are opened properly, they are far less likely to get under one's clothing than black bees. Queenless bees are not as quiet as those that have a queen. It may be because they seldom work with energy, and have therefore no fresh accumulation of stores that would tend to put them on their good behavior. All bees are much worse after a sudden stoppage of nectar secretion, especially after a basswood or buckwheat flow. A great many stings are received from bees that are in no way badly disposed at all, simply from getting pinch-

ed accidentally while on the person of the beekeeper.

The pure races, except Cyprian, Syrian and Holy Land bees, may be handled all day with no mishap; but after working among the old-fashioned blacks or hybrids one often finds a dozen or more under the coat, in the sleeves, if they can get up, and, worst of all, up the trousers, unless the precaution has been taken to tuck them into the boots — or stockings when wearing low shoes. (See Veils.) This one thing alone should decide one in favor of the Italians, Caucasians, or Carniolans, if they were no better than the blacks in other respects. Hybrids, as before stated, are worse to sting than either of the races when pure; while Cyprian, Syrian, and Holy Land bees are so much worse still that sometimes smoke has no effect on them. (See Cyprians, under Races of Bees.)

Bee-sting Poison

When bees are very cross and elevate that portion of their bodies containing the sting, a tiny drop of some transparent liquid can often be seen on its point. This liquid is the poison of the bee's sting. It has a sharp, pungent taste; and when thrown in the eyes, as sometimes happens, it has a stinging, acrid feeling, as if it might be a compound of cayenne pepper, onion-juice, and horseradish combined; and one who tastes it or gets it in his eyes concludes it is not so strange that such a substance, introduced into the circulation, should produce severe pain and local fever for a few hours.

How It Is Done

It is quite an interesting experiment to let a bee sting one on the hand, and then observe the whole performance without disturbing it. After the bee has worked the sting in so deeply as to be satisfied, it begins to find itself a prisoner, and to consider means of escape. It usually gets smashed at about this stage of proceedings unless successful in prying itself away; however, if allowed to work quietly it seldom does this. After pulling at the sting to see if it will not come out, it seems to consider the matter a little, and then commences to walk around the sting in a circle, just as if trying to twist a screw out of a board. If one can be patient and let the bee alone, it may work it out, but in most cases the sting either tears out from the body of the bee or breaks off. In either case it should be removed from the flesh at once.

Odor of Bee-sting Poison

After one sting has been inflicted, there seems a much greater chance of getting more stings. This is owing to the smell of the poison. The use of smoke will neutralize this scent. It is advisable to blow smoke on the wound. The heat relieves the pain somewhat, and the smoke does, no doubt, obscure the bee-sting odor.

Mechanical Construction and Operation of the Sting

After a bee has delivered its sting, and torn itself from that member, a bundle of muscles partly enveloping the poison-bag will be noticed. The curious part of it is that for some considerable time after the sting has been detached from the body of the bee, these muscles will work with a kind of pump-like motion forcing the sting further into the wound, as if they had a conscious existence and burned with desire to wreak vengeance on the party attacked. Even after the sting has been pulled from the flesh, and thrown away, if it should stick in the clothing so the flesh will come in contact with it, it will commence working again, pull itself into the flesh, and empty the poison into the wound precisely as if the living bee were itself working it.

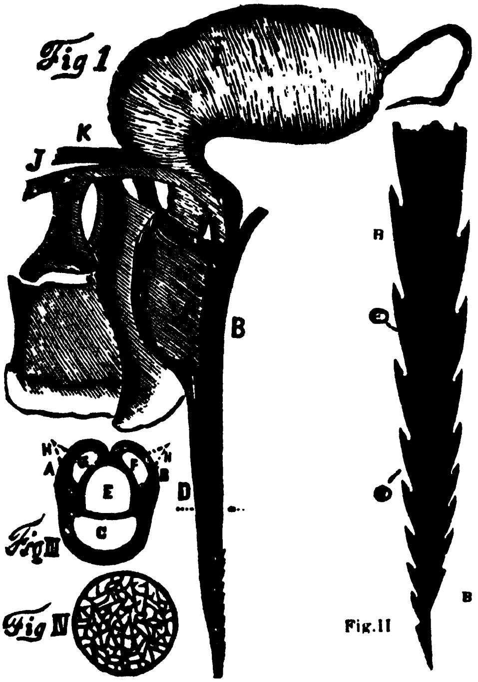
The author has suffered many times from a sting unconnected with any bee. It would hold life enough to give a very painful wound for some minutes.

Muscular contraction of the sting has taken place under the field of the microscope 20 minutes after being detached from the bee. This phenomenon is wonderful, and, while watching the sting sink into the rim of a felt hat, one can ponder on that wonderful thing, animal life. Why should that isolated sting behave in this manner, when the bee to which it belonged is perhaps far away, buzzing through the air? Why should this bundle of fibers and muscles behave as if it had a life to throw away?

Under the microscope the sting is found to be a beautifully fashioned and polished instrument, whose delicate taper and finish make a most surprising contrast with any instrument man has been able to produce. In shape it appears to be round; but it is, in reality, egg-shaped, of a dark-red color, but transparent enough to show the hollow.

The sting proper is composed of three

parts — the outer shell or husk D, and two barbed spears that slide partly inside of it. Fig. II shows the spears. The barbs are much like those on a common fishhook, and when the point of one spear, A, penetrates far enough to get one barb under the skin, the bee has made a hold, and has no difficulty in sinking the sting its whole length into the wound; for the



Bee-sting magnified.

pumping motion at once commences, and the other spear, B, slides down a little beyond A, then A beyond B, and so on. With a motion like that of a pair of pump-handles, these spears are operated by small but powerful muscles attached thereto. These muscles will work, at intervals, for some time after the sting has been torn from the bee, as has been explained. They work with sufficient power to send the sting through a felt hat or into a tough buckskin glove. It is interesting to watch the bee while attempting to get its sting started into the hard cuticle on the inside of the hand. The spears often run along the surface diagonally, so that it can be seen how they work down by successive pumps.

The ducts OO, it is believed, are for the purpose of conducting the poison from the poison-bag up the barb.

Fig. III is a transverse section, sliced across the three parts, at about the dotted line D. A and B (Fig. III) are the barbed spears; F and G (Fig. III) the hollows to give them lightness and strength; H, H, the barbs. It will be observed that the husk, D, incloses but little more than one-third of the spears. The purpose of the main shaft C is to hold the spears in place, and to allow them to slide easily up and down also to direct them while doing this work. To hold all together, there is a groove like a sliding dovetailed joint in both spears, with a corresponding hollow groove in the husk, which fit each other as shown. (See Fig. III.) This allows the barbs to project to do their work, and yet holds all together tolerably firm, for these spears are very easily torn out of the husk; and after a sting is extracted they are often left in the wound, like the tiny splinters before mentioned. When torn out and laid on a piece of glass they are scarcely visible to the naked eye; but under the microscope they appear as in Fig. II.

Stings do not all have the same number of barbs. There are as few as seven and as many as nine. The two spears are held against each other as shown in Fig. III, and it will be observed that the shape and the arrangement of the three parts leave the hollow, E, in their center. The working of the spears also pumps down poison, and quite a good-sized drop will be collected on their points, as can be readily seen under the microscope.

STINGS, THE REMEDIAL VALUE OF.—The material given under this head is taken from a new book published concurrently with this volume, entitled "Bee Venom, Its Nature and Effect on Arthritic and Rheumatic Conditions," by Dr. Bodog F. Beck, a specialist in New York, one who has spent a lifetime of study and gathering of material on the use of the poison in the bee sting, in the cure of certain diseases in the human family. The publishers are the Appleton-Century Co. The vast amount of testimony that he has gathered from lay as well as medical men is astounding. The cures ascribed to bee venom are almost miraculous, not to say unbelievable. For years the author and editor of this A B C and X Y Z of Bee Culture has been saying in his public lectures and articles on bees that the pain of the bee sting was so great that it com-

pletely obscured the rheumatic pains and hence led the sufferer to believe he was cured. In other words, he has implied that there was no virtue in bee poison as a remedial agent. The evidence presented in Dr. Beck's book is so overwhelming and convincing, especially the testimony from medical men, that he feels that it is his duty to present a review of this work and let the public draw its own conclusions.

If the reader has rheumatism and is convinced that bee stings will cure him, he should take one or two stings at first, and if he suffers no severe reaction, take more. The heart action where many stings are taken, should be checked by a physician. A person past middle life may have a weak or defective heart. If so, he should go slow.

We are giving here a review of Dr. Beck's book, which certainly merits a careful reading.

Current Beliefs on the Value of Stings

The belief that people, when stung by bees, are cured of rheumatic ailments has been handed down for generations. History mentioned that Charlemagne, the great conqueror (8th century) was cured of his obstinate gout by bee stings. From time to time statements have been made that it also prevents cancer and promotes longevity. There are several resorts in Europe where "bee-sting cures" were and still are administered and regular pilgrimages are made to these places by rheumatics who travel there from faraway countries to secure relief from their painful afflictions. Even physicians have submitted themselves to these "treatments."

Many periodicals have received reports of cures effected by bee stings, with the request that the medical profession should investigate the facts. Often even medical papers have referred to these reports, and some physicians have sent out questionnaires to medical fraternities, asking for information as to whether they have any knowledge of such cures. Numerous replies were received, in which the writers stated they knew of cases where even crippled and paralyzed patients have been perfectly cured by bee stings.

It has also been reported that beekeepers during their occupation, continuously exposed to stings, and acquiring immunity to their effects, never suffer from arthritis, rheumatism, or gout. If they were afflicted with these maladies before taking up beekeeping, they are usually cured, without suffering any further recurrences. This has been denied by a few beekeepers who claim that they suffer as before.

The response from the medical profession to these appeals has been rather slow. This is only natural, for only a physician-beekeeper was capable of administering such treatments. Of course, an ideal combination would be a physician joining hands with a beekeeper, but professional men, as a rule, are unwilling to do this.

Meanwhile, in entomologic and bee journals, and in the daily press, scattered articles have appeared about inexplicable cures produced by bee stings. For many centuries it has been their favorite topic. Here are some of them:

More than a century ago, in the German Frauendorfer Blatter, an article appeared, reporting the occurrence of a peculiar case; a woman with a paralyzed arm was stung by a number of bees and, as a result, recovered the use of her arm. The writer of the article appealed to the medical profession to explain this miracle. suggesting and inviting a thorough investigation.

T. P. Demartis, of Bordeaux, France, who wrote a series of articles about the use of animal venoms in medicine, published a letter in L'Abeille Medicale (July 25, 1859) which he received in connection with his research work, from a M. De Gasparin, describing his experience. M. De Gasparin was reduced to permanent infirmity by chronic rheumatism and bronchitis. He tried all medicines and various spas—without obtaining any relief. One day, while walking in his garden, he was stung by bees on his arm. The arm swelled considerably, but his rheumatism disappeared. De Gasparin farther stated that with the same method he later cured his chronic bronchitis and also a painfully swollen gland. He had knowledge of other rheumatic cases cured the same way and also of two cases of cancer of the face. De Gasparin complained that, though he mentioned these facts to several of his medical friends, they not only did not attach any importance to his statements but instead absolutely ridiculed the whole idea. He requested Demartis to champion this authentic information and make a propaganda for it.

M. Lukomski, Professor of Technology at the Institute of Forestry of St. Petersburg (Leningrad), Russia, published an article in the Gazette des Hopitaux (No. 107, September, 1865), reporting the cures by bee stings, not only of rheumatic and neuralgic ailments, but of intermitent and remittent fevers and various tumors. He suggested that the medical profession try this method for pest and cholera. Lukomski suggested the technical term apisination for the procedure.

Several years later P. Fabre lectured on the subject before the Academy of Medicine in Paris, referring to these publications and also reporting his own experiences. A "poor devil" near Nice, crippled by rheumatism of his legs, exposed them to bee stings and was perfectly cured. Two other inhabitants of the vicinity had similar successes.

The Annal de Societe Entomologique quoted several cases. A veteran, Fernand de Vingeanne, who had acquired a very bad rheumatic ailment during the 1870 campaign, was completely cured of it after he had been stung by bees. A retired facteur rural (letter carrier), who for some time had been unable to walk, fully recovered after being stung by about a dozen bees. The Entomologische Nachrichten (1878) occasionally published similar remarkable cures.

A brewer, stung by about half a dozen bees, lost his painful gout, and all his symptoms disappeared. A nine-year old child of an innkeeper, in Rettenbach, Iberpfalz, previously unsuccessfully treated for the ailment with all possible methods, recovered perfectly after having been 'exposed' to a number of bee stings.

The London Medical Record (XII, 1885, page 178), stated: El Siglio Medico, related a singular case from a Plaz, Bolivia: A woman suffered so much from rheumatism for six months that she was hardly able to sleep. Her right arm was absolutely useless, she could not even dress herself. She heard about cures from bee stings, procured some bees, applying only three stings the first day. The result was so surprisingly beneficial that the following night she was able to sleep and her pain entirely disappeared.

Dr. Packer, of Kansas City, in 1904, reported a case of a man named Gardner, who had been afflicted with articular rheumatism for four years, and unable to walk except with the help of crutches. In August, 1903, he was hobbling around the yard when he fell against a hive and upset it. The enraged bees pounced upon him and he was nearly stung to death. He became very ill, but recovered and found that his rheumatism had disappeared, suffering no further attacks.

In 1910, Dr. Ainley-Walker published a questionnaire in the British Medical Journal, in an effort to ascertain whether there is any truth in the popular belief that bee stings cure arthritis and rheumatism. He asked for evidence in favor of it or to the contrary, and also about the character of the rheumatics who were stated to be cured. Here is what he received:

A physician, Dr. Burton, of Birmingham, for instance, answered that he had tried this "inoculation" on himself. He was attacked by acute arthritis of the right hip, and sciatic neuritis. Nothing gave him relief. He sent for some bees, and after receiving his supply he put about eight over the sciatic nerve and the hip joint. Next morning, when he awoke, not only was he able to turn in bed but he could walk across the floor without limp or pain or the necessity of holding to the bedpost, as he had had to do for the previous three months. He put six more bees on, the same evening another six, and the final installment two days later. Afterwards he was able to run fifty yards without pain. He added that he was 67 years old, had been a rheumatic subject for the previous twenty-five years, and had decided to continue the application of bees. Nothing had given him a more "avaricious" appetite. Burton later administered the stings to his own patients and reported remarkable results.

A layman (J. D. M.) wrote to Dr. Walker from Australia that he had suffered from rheumatism of the shoulder for twenty-five years. Nothing helped him. He decided to try bee stings. He applied them to his shoulder and by the end of a week he was free from rheumatism. A year later, the ailment returned. He put on twelve more and forty-eight hours later six more, and was then free again for three years. A short attack was similiarly treated, and since that time he had had no recurrences. The same correspondent cited another case, a woman whose hands had been "stiff and gnarled" from rheumatism. She was accidentally stung by bees on her hands, and by the end of a week her fingers became almost as "lissom" as ever.

Surgeon Major-General Johnson, of Virginia, wrote to Dr. Walker that the belief was prevalent in the United States. He saw the "treatment" applied in the case of W. T., for acute rheumatic fever, with 103° F. temperature, with the result that in 24 hours the temperature became normal, the joints were free from pain and freely movable. The same patient later reported a subsequent attack, which was similarly cured.

Dr. McLay, of Lincolnshire, cited a case of rheumatism of the shoulder, with great stiffness and pain of two or three months' duration, which was cured by accidental bee stings on the hand.

Dr. Valentine Rees reported that he himself had lumbago for a week, and was absolutely unable to move. A clergyman, who suffered from chronic gout for many years and began beekeeping for that reason (since which time he had been practically free from pain), applied the bee treatment to the doctor. The doctor immediately recovered.

A physician, answering Dr. Walker in The Lancet, related an interesting episode as proof of the belief that bee venom is used for rheumatism. He was traveling on a cargo boat when one of the mates showed him an apparatus used by his father, who had suffered from a severe case of "rheumatism of the spine." The contrivance consisted of a cylinder and a piston, the latter being suddenly released by a spring. On the "business end" of the piston there was a concentric set of projecting needles. The apparatus was applied over the affected parts producing scarification. It was an instrument similar to that which is employed in modern tatooing but instead of ink, a dark viscous solution was used, which was given to the mate's father by a German chemist. This was prepared from the venom of the bees. The informant told the doctor that his father had derived great benefit from its use.

Only a comparatively short time ago (1913), an article appeared in France in the Journal de la Santé, relating quite a number of cases cured by bee stings, and requesting the medical profession to kindly take these facts under consideration and explain them. A farmer who could hardly move on account of rheumatism, was stung one day by several bees. He noticed immediate relief and notified his family physician, asking him to continue the "treatment." The physician applied eighteen bees weekly. The result was almost miraculous. The same physician later on had similar success in other cases. For instance, he treated a young girl who suffered from a painful rheumatic condition, and a violinist who for years had been unable to hold a bow in his hand but soon after treatments he was able to resume his profession. Even in chronic cases, this physician found bee stings to be a valuable remedy. The treatments were started with five or six stings, the number being increased to twenty-four weekly, according to age. The doctor put the bees on the skin with a forceps and kept the stings in position for about five minutes.

Henry Bouquet, medical correspondent of Le Temps, in the January 31, 1924, issue, said:

I wrote an article some time ago about the grave dangers of bee stings and I think it is time now to be fair to the little beasts, to rehabilitate them and speak about the wonderful

curative value of their stings. It is rather strange, that in spite of all the testimonials in its favor, this method is still under consideration by the medical profession.

Various other scattered articles have been published in the foreign medical press. Marfort of Geneva, E. Monin of Lyon, and Kruger of Nimes, reported cures of chronic cases of rheumatism with bee stings. Larmache of St. Marcellin, stated that several of his patients assured him they had used the method with great success, after all other remedies failed. Lamarche, himself, suffered from neuralgia and rheumatism, but after taking up beekeeping, exposing himself to stings, he was cured. He tried the treatment on a woman who suffered from an extremely painful sciatica, spending her nights groaning in agony. She obtained relief after only five stings and was entirely cured in a few more sittings.

The correspondent of the New York Times reported from Kansas City, Missouri, in the July 29, 1928, issue, that the oldest resident of Olathe, Kansas, maintained for years that nothing was quite as effective for rheumatism as bee stings, but said, of course, the younger generation scoffs at that. He stated that F. B. Haskin, President of the Patrons Bank, who did not class himself a believer of this theory, suffered from rheumatism for 6 weeks. One day his son called to him that the bees were swarming on his farm. He hobbled out and the medically-inclined bees apparently thought that he had come for treatment, so they stung him on the face, arms and back. Altogether he received 5 stings. Next day he was entirely relieved from his rheumatism. He said he was not a new man by any means, but certainly a repaired one, and recommended bee stings to anybody who had hardihood, fortitude and . . . rheumatism. The little "buzzers" do the work.

In one of the Duluth, Minnesota, papers an article appeared (November 11, 1933) which stated that August Halgren, 73 years old, who had been badly crippled with rheumatism seventeen years ago, started a bee farm at the time because bee stings were supposed to cure rheumatism.

"It worked," he reported. Not only did it work, but it provided Halgren with a prosperous business. He now maintains a farm of 157 bee hives. All comers are supplied with enough bee stings to cure their rheumatic pains. A Duluth grocer, virtually crippled when he first visited Halgren's farm, credits his bees with a complete cure. Halgren charges nothing for the treatment at his "bee clinic." "I was cured by a good will offering and that's the way I will cure you," he tells each patient.

Recently (1933) during the opening of National Honey Show in the Crystal Palace, London, one of the exhibitors, W. A. Whitlam of Thornton Heath, said:

I suffered from rheumatism so acutely that I had to take to bed. I took up beekeeping and like all beekeepers I was stung frequently. The more I was stung the less I was troubled with rheumatism. This year I was stung hundreds of times and my affliction has gone. Sufferers from rheumatism are less subject to swelling from stings than normal people and they also feel less pain.

Dr. Beck remarks that the enumeration of all these cases which he has quoted has really no scientific significance or value except for the fact that the consistent reports ought to have been of sufficient importance to arouse medical attention.

But the response from the medical fraternity was not appreciable, the reception was rather cold, mingled with a certain amount of doubt—even ridicule and contempt. It was a lay discovery and to enter into competition with the laity was below the dignity of any member of a high and noble profession.

The experiment (?) was taken up ages ago, dropped and revived many times. It was brought to life for a while, just to be discarded again. It was a tedious and tinkering performance, with plenty of inconveniences, often difficulties, requiring a great amount of perseverance to carry out the treatments. It was frequently revived because there was a great need for a remedy to cure such maladies as arthritis and rheumatism, in most instances refractory to all other medications.

Chronic or Severe Cases Require More Stings

Dr. Phillip Terc, an Austrian provincial physician of wide repute, was certainly the greatest exponent of bee venom therapy. Terc used live bees in thousands of cases for over forty years, with such success that he made the statement that almost every case of true rheumatism or arthritis can be cured with bee stings. Terc thought that there must be an intimate relationship between the venom of the bees and rheumatic conditions; namely, a sufferer from rheumatism does not react to the effects of the venom in the same manner as a normal person does. The more chronic the case is—the less reaction is evidenced. Sometimes Terc was compelled to apply 150, even 200 stings in one day to a patient without being able to provoke a reaction.

Through perseverance, Terc even succeeded in curing arthritis deformans in a person who was completely crippled where the disease had persisted for many years, but he had to apply altogether as many as 5600 stings to the patient. The condition gradually improved, patient looked fine, was able to attend to work, and walked for hours without pain.

What influenced Terc to employ bee stings in curing these ailments was that

he himself suffered from an obstinate case of rheumatism. One day he was painfully stung by a number of bees with the result that his ailment was cured. He heard similar reports but ridiculed the idea as much as others still do. His experience impressed him, he realized that it was a remedy worthy of trial but he did not know how to go about it.

His first case was treated in 1879. A woman, suffering from a severe case of neuralgia in the head and deafness, came to him for advice. So far her ailment had defied all treatments employed by other physicians. Terc himself could not give her any relief, though he used his best efforts. One day the discouraged patient expressed her disappointment, and said she had surely depended on his good and great reputation and expected that he would employ a new method which would afford her some relief. Terc remembered his own experience. Anxious to help, he decided to try the application of bees. Terc called on her daily, putting bees on her head. The stings had no effect on her. He applied about ninety stings without any reaction or improvement, which fact greatly surprised him. One morning he applied 15 more stings on her neck and shoulders. The patient later sent for him to come without delay. Arriving at her hotel, Terc found the patient's face terribly swollen—she was unable to open her eyes but she was jubilant, as all her pains for the first time in a long while were gone and she clearly heard the sound of the church bells. She was permanently cured.

This case greatly impressed Terc and gave him plenty of reason for reflection, also an impetus for further experiments. He could not comprehend why the patient did not react to the stings and when she responded only then the improvement manifested itself. Later experiences confirmed the supposition that mild cases react to a few stings and obstinate cases require hundreds of stings, the delay in reactions mathematically corresponding with the chronicity of the case.

Terc was very proud of his success in treating inflammatory rheumatism, for which ailment he considered bee stings a specific. In one of his reports in 1912, Terc published 660 cases of all types of arthritis and rheumatism, out of which number he achieved success in 82 per cent. Some of the patients gave up the treatments, which accounted for part of his failures. Alfred Keiter of Graz, Austria, Terc's assistant for many years, continued his work and the two physicians published excellent results in well over 2000 cases which they treated.

The Experience of Ernest Lautal

Another illustrious champion and friend of apitherapy was Ernest Lautal of Marseilles, France. He was an apiarist and besides, a philanthropist. His treatments were not restricted to rheumatism alone, but to various other diseases so far considered incurable. He had a model apiary and an office, where in addition to rheumatism and gout, he treated lupus (skin tuberculosis), cancer, eczema, and leprosy.

Lautal stated that he never thought the stings of the honeybees would cure all these ailments, as only a few physicians recognized their curative effects. He cured many desperate cases—where the sufferers were ready to make an end to their lives—and were later happy at being cured. To quote Lautal:

> For many years I suffered myself from an obstinate eczema over the whole body, especially on my hands and forearms. I was under the treatment of many dermatologists but could not obtain any relief. One day while handling bees, I was attacked on my left arm, against my wish, by a great number. The accident was for me a source of great anxiety, not only because it caused me considerable pain, but I was afraid that my skin trouble would become worse. To my great astonishment the eczema soon entirely disappeared from that arm. The incident gave me an idea and I tried the same treatment upon my right arm and exposed it voluntarily to bee stings. The result was likewise satisfactory. I continued the experiment and succeeded in curing all my skin disease. I administered the same treatment with great success to others.
>
> I then extended the field of my experiments in the treatment of tuberculotic affections of the skin and had unexpected and surprising results. Obstinate and rebellious cases of neuralgia also rapidly yielded to apipuncture and I can see the time when this treatment with bee stings will be an accepted method for rheumatism eczema, lupus, cancer, leprosy, and many other diseases.

Lautal stopped epileptic convulsions with bee stings. He also suggested their application as a control in doubtful cases of death, in the absence of a physician, as bees obstinately refuse to sting a corpse and if the act is forcibly induced it will not provoke an inflammatory reaction as on a living person.

Lautal's successes aroused so much recognition that he was permitted to install apiaries in the principal hospitals in Marseilles and patients were entrusted into his hands for treatments. Professor Boinet introduced several cases of leprosy and lupus cured by Lautal's method.

Other physicians of Marseilles greatly praised his procedure.

Bee Venom Artificially Injected

During the last few years, several scientists have succeeded in extracting the venom of the bees, and have dispensed the substance in vials, to be injected into the skin. The administration of this injectable bee venom, faithfully imitating the bee, is supposed to have the same effect as the natural stings.

The ampoules contain solutions of increasing concentration. The treatments commence with weak solutions and doses of increased potency are administered with the advantage that it is not necessary to apply many stings; one injection sometimes represents the amount of venom contained in approximately 30 or more stings. The modernized treatment makes it possible to use the venom the whole year around, in any place, at any time, and one is not dependant on procuring live bees, which, for city dwellers, is rather circumstantial and expensive. Hospital patients, too, can be treated through this innovation with success.

The Potency of Injectable Bee Venom

Dr. Beck remarks that the potency of the foreign injectable venom often varies and in such an instance it is usually inadequate. He thought that we are still far off from the time when we can claim that injectable bee venom is just as good as the original curative dose of our little friend, the bee. He believes the domestic production of an efficient and reliable injectable bee venom is an urgent desideratum and he is hopeful and confident that this modern application of the age-old remedy will prove a great boon and blessing in our endeavor to check the progress and eventually quell the ravages of these world diseases.

International authorities like Prof. Perrin, of the Faculty of Nancy, France, highly praised the medicinal value of the venom. Perrin introduced 19 cured cases, during the Third International Congress of Rheumatism, in October, 1932, and stated that bee venom has a remote action, particularly on regions affected by rheumatism. He undertook, with great skepticism, his researches concerning the antirheumatic effect of the venom, but he is now convinced of success even in cases which have so far been refractory to all other medications.

Prof. Maurice Roch, of the Medical Faculty of Geneva, reported several cases in which excellent results had been obtained. Roch even tried the venom on himself for a knee ailment, after an amputation had been suggested. While no other remedy had helped him, the injections of bee venom effected a cure.

Dr. Beck quotes many other authorities who use injectable venom at the present time. They all agree that it produces no harmful effects, improves the general condition, appetite and sleep, increases weight, and affords considerable relief from pain. He says:

In the April 28, 1934, issue of the British Medical Journal, an article appeared by Drs. Shipton and Burt, honorary physicians of the Devonshire Royal Hospital, stating that they had obtained excellent results in treating arthritic and neuritic cases and fibrosities with a foreign injectable bee venom preparation but they complained that the Ministry of Health had stopped its importation because a license was required. The doctors thought it was very lamentable that the Ministry obstructs and prevents the use of a well recognized remedy which hospital patients, suffering from certain ailments, urgently require.

Dr. Herbert White, in connection with the above letter in the May 19th issue of the same journal, related one of his experiences, that of an agricultural laborer, crippled with arthritis, who was absolutely unable to work. He could not even grasp the handles of his wheelbarrow. Dr. White recommended bee stings. The patient went to a beekeeper, who applied, once a week, a dozen bee stings on each hand. In three months, completely cured, he was able to return to work. Dr. White thought that the manufacturing chemists ought to be able to put up bee venom adapted for treatments.

Questionnaire Sent Through Gleanings in Bee Culture

Dr. Beck, in anticipation of publishing his book, wished to ascertain how prevalent the belief is in the United States that bee stings have curative effects. He sent out a questionnaire to beekeepers, which was also published in the November, 1933, issue of Gleanings in Bee Culture. In it, he appealed to the beekeeping fraternity to assist him in the study of this interesting and important problem. He was mainly concerned with beekeepers' sensitivity and immunity to stings, the symptoms produced by the injuries, the favorite remedies which were universally employed, and above all, whether beekeepers ever acquired arthritic or rheumatic ailments during the pursuit of their occupation, and if they suffered from these maladies before taking up beekeeping, whether they were cured or subjected to recurrences. Dr. Beck received hundreds of replies, not only from almost every state of this Union, but from England, Canada, Nova Scotia, Hawaii, even from

Australia, New Zealand and South Africa. Through these informative answers he obtained a mass of valuable and instructive material.

Dr. Beck expressed surprise at the popularity of these treatments in the United States. He received many reports of remarkable results from beekeepers who had regular "roadside clinics" and cured patients of these ailments. Some reported that they had taken up beekeeping on account of obstinate arthritis, but after having been repeatedly stung, their condition not only gradually improved but they were finally cured. Dr. Beck quotes many replies, and some of them are certainly astonishing.

A veterinary surgeon (C. S. C.), of Rosedale, Indiana, reported that 20 years ago he contracted a very obstinate case of inflammatory articular rheumatism. He was bedfast for four weeks, had to be turned on a sheet. For five years he was compelled to go to bed every spring. He went to spas, took salicylates, and all other antirheumatic remedies, besides boiling, sweating and other "trimmings." Finally, he took up beekeeping and for the last fifteen years has had no rheumatism—that is, ever since he has kept bees. He gave credit to the bees for curing him, emphasizing that they didn't even charge him a cent for it.

E. B. K., of Lititz, Pennsylvania, wrote that about 38 years ago he contracted rheumatism, and the doctors tried everything, without success. After years of pain, he decided to try bees. He made the bees sting him from the right hip down. He received only 30 stings, and the pain left him. Ever since he has had no rheumatism. E. B. K. closed his letter with the remark, "I certainly do stand up high and shout very loud for bee stings."

L. K., of Indiana, wrote that he had two attacks of rheumatism before keeping bees, both of which had been severe enough to disable him for six weeks at a time. Since he has been keeping bees, he has had no return of the trouble.

J. W. P., of Puyallup, Washington, reported, concerning the curative effect of the venom, that he knew an educated German beekeeper, Mr. Stolley, who conducted a whole clinic in his apiary, and successfully cured patients of rheumatism. He mentioned the case of a county commissioner who suffered from this disease for years trying several doctors without success. Finally, he had to resort to crutches. He was brought to the apiary each week. On each visit the stings were administered in increasing numbers. Before the summer was over, the man walked without crutches and went about his business as before. He said Stolley obtained many similar cures. J. W. P. added to his long and interesting report that he remembered reading in his earlier days of beekeeping a statement made by the late A. I. Root: "You'll very seldom find a beekeeper who is troubled with rheumatism." His experience is the same and he found the statement to be true. He can not recall a single case of a beekeeper who has had rheumatism.

C. S. B., of Shelton, Washington, related that he had rheumatism when a small boy and the doctors who treated him told his mother he would be afflicted in later years. He remarked that as a person subject to rheumatism he can offer some valuable testimony along this line. He has handled bees for 50 years and always feels a pleasant glow after a sting and when the poison takes effect. He thought some people would laugh at this report, but he is convinced that the stings benefit him. Last June he felt a "twang of rheumatics" in his left shoulder. He picked up a bee, pressed it against his arm, picked up another, pressed it into the hollow of his elbow until it had done its duty, then picked up another and pressed it just above the elbow. In three days, he felt no rheumatic symptoms. He stated that he is 78 years old, full of pep and vim and he fully believes that bee stings are a great help.

G. S. McR., Thief River Falls, Minnesota, reported that when he was a boy between the ages of 10 and 17 he had a number of attacks of rheumatism, one of them being so severe in the muscles of his chest that it affected his heart. He occasionally swooned away like dead. From 17 to 21 he worked with bees and had suffered no illness and no recurrence. During the winter of 1911, he worked in Fargo, North Dakota, in a creamery where it was wet and he was obliged to deliver milk without changing clothes. Next spring he had rheumatism in his legs so badly that he was unable to walk. During the summer he got over it. He has worked with bees every summer for the last 13 years and has been entirely free from pain. One fall he had slight pains in the shoulder. He went into the bee cellar, made a couple of bees sting him on the back of his hand, and in a day or two felt no more pain.

C. M. P., of Excelsior, Minnesota, wrote that he is 75 years old. He lived in Ohio until he was 23, where his father kept bees and he was often stung. From Ohio he moved to South Dakota, where he did not come in contact with bees. Before coming to Minnesota about 20 years ago, he contracted rheumatism, which at times was very acute. He took up beekeeping. His first experience was an accident with bees. He was covered with them and each one gave him a full dose of rheumatic cure. The response was immediate and the treatment was so effective that since that time he has had no rheumatism worth mentioning, though during the last ten years he has had only a few stings, as his son is looking after the bees.

C. W. S., of Oklahoma City, Oklahoma, had rheumatism of the shoulder and kidney trouble when 35 years of age. He took up beekeeping, and now he is 71 years old and entirely free from these ailments.

L. M. S., of Harrison, Ohio, was glad to have an opportunity to tell his personal experiences, which cover a period of 40 years. Some time ago, he gave a hive of bees to a boy neighbor who had inflammatory rheumatism. As the neighbor was "green" even with extra clothes on he received some "good" stings, which made him sick. He took some whiskey and went to bed. Later the boy remarked: "I'll be blank if I don't believe bee stings are good for rheumatism." He never felt any rheumatism since and today the same boy is a husky policeman in Chicago. L. M. S. also related a case of a man who worked for him six years ago in Montana. On a hot day the man took off his veil and was properly stung on his face and hands. Next spring he remarked that it was the first winter that he did not have rheumatism and he wondered why.

A. T. W., of Arcadia, Nebraska, answered question about rheumatism: "Yes, that is why I began keeping bees. Had rheumatism so that I could hardly get around. About 20 years ago I read that bee stings were good for my affliction. I secured four colonies of mongrel bees, and 15 seconds later the stinging began. I believe these four colonies could have won the World War." By the next season he felt pain only occasionally and for the last 16 years has had no recurrence. He is 67 years old now, without a day of sickness, and attends to farm work and stock raising. A half-brother of his, a doctor in Kemmerer, Wyoming, told him he used "Apis" for rheumatism with success.

C. A. Z., of Livonia, Missouri, who has worked with bees for over half a century (since 1879), welcomed the opportunity to communi-

cate his varied experiences and give some information for compiling a book about rheumatism. In spite of advanced age, his hands and fingers are limber as a child's and he does not suffer the agony that others do. His wife had such rheumatism of the knee that she could walk only with a cane. He made her help him with the bees. She received stings on the affected parts, and it was not long until she was walking again without a cane. She has not suffered from rheumatism since. Five years ago a traveling salesman came to their house and asked for permission to let the bees sting him. He said that five years before he had rheumatism so badly that he was carried to a beeyard on a stretcher and stings were applied. This was the first time it had recurred. The stranger went to the yard and helped himself to stings. When he departed, he seemed to be "relieved." C. A. Z. had not seen him since.

L. M. D., of Edmeston, New York, wrote that he is 67 years old and handled bees for a long time. He had rheumatism before caring for bees, but has been free of it since and he considers bee stings a cure for the disease.

A. R. F., of Levy, Arkansas, reported that he had rheumatism and took all kinds of medicine for it without result. One Sunday morning he was stung on the chest by six or eight bees and in no time he was cured.

B. H., of Ste. Martine Chateauguay County, Quebec, Canada, wrote that he has been keeping bees for nearly 25 years. Last summer he had such a sore back that he was unable to walk. Nothing helped him. Finally he decided to use his own bees. He took about a dozen, applied them himself on his back. At once he felt better. An hour later he took another "dose" and next morning 15 more bees. He could then walk and dance. B. H. related another experience. A friend of his suffered from rheumatism of the arm for two weeks, the last two days hardly able to sleep. He asked his friend if he would object to bee stings for a "sure cure." He said: "I will stand anything to get rid of this pain." B. H. at once got a dozen bees, and went to the home of his friend "like a family doctor." Everybody ran out of the house afraid of being stung. He proceeded to give the "patient" 10 stings on the arm. That was Sunday afternoon. Monday morning his friend went to work on the job he left two weeks before.

G. B. H., of Creston, Iowa, stated that before he took up beekeeping in 1917, he suffered from some form of rheumatism. After he worked with bees and received several stings, all traces of the trouble left him. In 1928 he sold his bees and for several years he continued to visit other beekeepers to do some work just for fun, which, of course, resulted in several stings. From the year 1931 until the winter of 1932 he had no contact with bees and developed a painful attack of arthritis of the right elbow. The pain was so bad that he could lift his arm or grip an object only with difficulty. He was talking to a boy whom he had a few years ago interested in bees and asked him to get him some, the first warm days they were out. The boy brought him 10 bees in a queen cage. Before retiring that night he caused four bees to sting him over the elbow, leaving the stings in several minutes. By the next night two of the remaining bees were dead but he repeated the performance with four others as on the previous night. He noticed relief in 24 hours and in a few days all traces of pain were gone and no recurrence up to date (November, 1933).

G. H. H., of Taunton, Massachusetts, related in his reply that he suffered from sciatic rheumatism for 20 years before he kept bees. He can "truthfully say" that bees kept it away from him for the last seven years. Whenever he feels "anything like it," he goes to the bees and lets them do "their stuff."

A. C. K., Grand Rapids, Michigan, suffered from rheumatism of the right hand ever since an auto accident five years ago and has not been bothered by it since he was stung the first time.

H. M. M., of Boyertown, Pennsylvania, wrote: "I am working in my bee business for some 59 years. I am 80 years old, lean and tall, the same shape as my grandfather who always had rheumatism and several of my cousins died from it. I don't know what rheumatism is and I am sure bee stings will keep it from me. Dr. L. E. claims the same thing. Yes, bee stings prevent and cure rheumatism."

All these reports are very interesting and instructive. It proves how widespread the belief is that bee stings are efficacious for rheumatic ailments. Many beekeepers have told how often strangers visit them, asking for permission to go near the hives for "treatment." Some apiarists seem to be very proud of their "roadside" clinics.

Relative to the question about cancer, Dr. Beck received only one report, from H. R. C., of Honolulu, Hawaii, who related that a thin light-skinned Englishman who owned the bees he is now operating, died from cancer, which the doctor thought was due to the tropical sun. Many other answers mention the fact that, according to the writers' knowledge, cancer is almost unknown among beekeepers.

The chapter in Dr. Beck's book on the effects of bee sting injuries which are discussed in a scientific manner is interesting, instructive and informative. It will undoubtedly serve as a real textbook for physicians on the subject. To our knowledge, this is the first book ever written in any language which gives the chemistry of the venom and the pathology and clinical management of bee sting injuries. Dr. Beck must have spent a tremendous amount of labor, time, and thought to amass this amazing wealth of material. He quotes innumerable cases from the world literature to illustrate the circumstances and conditions on which the effectiveness of the stings depend. The influence of topograpical and constitutional conditions on bee stings is interesting reading matter, not only for medical men, but it is invaluable for anybody who comes in contact with bees. The chapter on fatal injures is full of surprises even to the oldest beemen.

In the second part of the volume, arthritic and rheumatoid conditions and their relationship to bee venom are discussed.

SUCROSE.—See Cane Sugar.

SUGAR.—The term sugar is applied by common consent to the white sugar commercially prepared from the sugar cane

and the sugar beet or to sucrose. To the layman and possibly to the chemist, the word "sugar" means white granulated sugar; if it is powdered, the adjective "powdered" is added to sugar as "powdered sugar"; if it is moist and soft, and either white or only slightly yellow in color, it is termed "soft sugar"; while if it is brown in color, moist and soft, it is termed "brown sugar." In distinction the word "sugars" refers to the whole class of sugars, of which there are some 150 or more, many of which are rare and some of more common occurrence. Grape sugar is the sugar dextrose, while fruit sugar is the sugar levulose. (See Invert Sugar and Honey.)

Common sugar is composed of the elements in the following proportions: Carbon, 12 parts; hydrogen, 22 parts; oxygen, 11 parts. It is found free in nature in many roots, as beets and turnips; in the stems of plants, as sorghum, sugar cane, cornstalks, and in the sap of trees like maple, birch, etc., and in many fruits. It has never been commercially prepared from the elements.

A white sugar or granulated sugar is practically pure sucrose, while the varying off-colored sugars ranging from light-yellow to brown are mostly mixtures of crystals of sucrose surrounded with molasses. These yellow or brown sugars are all produced by the refineries from the liquors after the production of the white grades. Formerly one had brown sugars direct from the cane, but now these are not produced to any extent in this country. Louisiana sugars in hogsheads used to be these old brown sugars.

There has always been a discussion as to whether white sugar made from beets is the same in every particular as that made from sugar cane. Both contain practically the same amount of sucrose, also water and mineral matter, but the organic impurities which may amount to from .05 to .1 per cent are often different in beet white sugar from those in cane white sugar. These impurities may play a part in some manufacturing processes, and prevent the use of beet sugar in all places where cane sugar has been used. However, as a sweetener and for table use or for jelly or preserving work it is doubtful whether there is any notable difference between beet and cane sugar. (See Cane Sugar.)

Corn Sugar

In 1927 there was put on the market a white granular sugar that looks like ordinary granulated cane and beet sugar except that the granules are opaque and not translucent as in cane and beet. It is nearly a pure dextrose, and, according to government chemists, it is only half as sweet as cane or beet sugar. It does not readily dissolve in water and is unsuited for making a syrup for bees. (See Honey, also Honey, Science of.)

SUMAC *(Rhus)*.—This genus is represented in the United States by about 15 species. Most of them are shrubs, but a few are small trees and one is a shrubby vine. The small flowers are borne in dense clusters at the ends of the branches or in the axils of the leaves. The stamens and pistils are usually in different flowers.

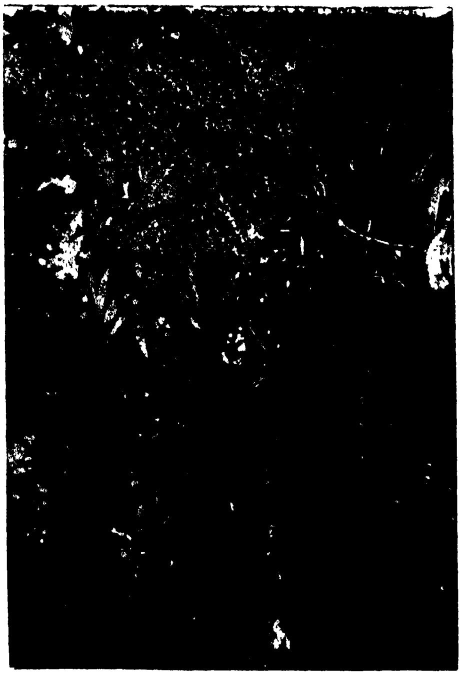
Staghorn Sumac *(Rhus typhina)*. This species reaches a height of 10 to 25 feet, and has orange-colored wood and crooked branches, covered with soft, velvety hairs, resembling the horns of a stag. The clusters of fruit are clothed with acid crimson hair. The staghorn sumac grows in dry soil from Nova Scotia westward to Missouri. The flowers are visited by honeybees in large numbers and, as the nectar is unprotected, by a great company of other insects. The flowers appear in June and July.

Sumac, smooth (Rhus glabra).

Smooth Sumac *(Rhus glabra)*. Upland sumac. Scarlet sumac. This species is an irregularly branched shrub, seldom more

than 10 feet tall. It has a very wide distribution, extending from Nova Scotia to Florida and westward to Mississippi and Minnesota. In Connecticut, where much of the surface is covered with glacial moraines, it is very common in hillside pastures and along stone walls. The blooming period lasts for about three weeks, from July 8 to the beginning of August. The flowers secrete nectar very freely on hot clear days, but in cloudy, foggy, or cool weather the flow ceases almost entirely. If there are "hot waves" in July strong colonies will bring in 20 pounds of honey during an ideal day, and will store from 40 to 100 pounds each. But if there is much cool or rainy weather there may not be an average of 20 pounds to the colony. At its height the flow is very rapid and heavy. While the bees are busy on the bloom there is a very strong odor in the apiary, and the new honey is more or less bitter to the taste. Fortunately, the bitterness is only transient, and by winter the honey is edible.

One must eat sumac honey to appreciate



Sumac flowers and leaves (Rhus glabra).

it, says Latham. There is a richness, but at the same time a mildness about it, that will suit the most sensitive taste. Once a customer, always a customer, if one buys sumac honey. When pure, the honey has a golden color. If properly ripened, it has no noticeable odor, but is very heavy, and, like apple-blossom honey, waxes instead of candies. It is safe to say that much of Connecticut would be worthless to beekeepers but for this plant.

The bloom also yields a large amount of pollen, great loads of which the bees bring in during a slow flow. Even during the height of the honey flow the bees gather pollen during the morning hours, before the sun has stimulated the nectaries. Later in the day little pollen is brought in. See "Honey Plants of North America."

SUNFLOWER *(Helianthus annuus)*.—An extensive American genus embracing 60 or more species. The common sunflower grows wild throughout the West, especially from Minnesota to Texas on the prairies and waste lands lying between the Rocky Mountains and the Mississippi River. In Nebraska it becomes a "veritable herbaceous tree," and completely takes possession of large waste areas 10 to 25 or more acres in extent. The tall plants also grow along the roadsides and about cities and towns. This species is likewise common in California, and one year M. H. Mendleson of Ventura extracted a carload of wild sunflower honey, but the yield had never before been so large. According to Richter, the honey is amber-colored, with a characteristic flavor not disliked by many. Scholl says that in Texas bees gather much propolis both from the flowers and leaves. The Jerusalem artichoke *(H. tuberosa)* is a good honey plant, and bees visit the flowers in myriads. In Contra Costa County, California, there are acres of this plant growing wild. The tubers are used as a vegetable.

Wild Sunflower of Florida

This name is rather loosely applied by beemen of Florida to various species of Compositate that grow over the southern half of the peninsula, including *Gaillardia lanceolata*, *Helianthella*, *Coreopsis*, and burr-marigold. South of a line drawn through Stewart and Osprey, the one on the east coast and the other on the west, there are thousands of acres of these beautiful plants, which resemble the Spanish needles and *Chrysopsis* of the North. They extend as far north as Osceola, but beemen of the southern third of the state are most enthusiastic over them. The "savannas" about the edges of the Everglades

seem to be their best habitat, while they are not common on high pine land. The blooming period is in September and October. The yield is rather unreliable, and nectar is secreted only during very dry falls. A fair crop can be counted on about every two or three years; a "bumper" about once in five years. The honey is amber, fairly good body and rather mild, but it is, after all, a fall-flower crop, and by no means ranks with the best honeys. It is fine for putting the colonies in good condition for the close of the year. See "Honey Plants of North America."

SUPERSEDURE OF QUEENS.—See Queens, Supersedure of.

SUPERING.—The word super means over or above. Used in connection with beehives it means a receptacle intended to receive the surplus honey, which honey is stored over and above what is needed for the food requirements of a colony of bees.

Keepers of bees in box hives or log gums sometimes bore auger holes in the tops of the boxes or gums and invert over them empty crocks in which to store honey. More often receptacles resembling modern supers are used in connection with box hives and log gums, for securing surplus honey. (See Box Hives.)

In using modern movable frame hives and supers in the production of extracted honey, a queen-excluder is usually put between the brood chamber and the supers. The first super is put on the hive directly above the queen-excluder. It was formerly the practice when this super was about half filled during a honey flow, to raise it up and put another empty super above the queen-excluder, but below the partly filled one. If still another was needed, it was placed directly over the queen-excluder and under the two supers previously given. It is frequently necessary to give four or five, and sometimes six or seven supers to a single colony.

With this old method of supering, the theory was that the bees will readily start work on the last super given because it is near the brood chamber, and at the same time they will continue work on the supers given previously. This theory sounds quite feasible and apparently it worked in practice. The main objection to this method of supering is that it requires too much time and labor lifting heavy supers off and on the hives.

Fortunately there is a much simpler method of supering. It is so simple that there is very little to it. It may be called the method of supering on top. In applying this method the first super is given as usual. When it is time to put on the second super, it is simply added on top of the first super. When the third super is necessary, it is added on top of the second super. If still more supers are needed, they are added on top from time to time as needed.

This method of supering has a number of distinct advantages over the other method.

1. One can easily tell by simply lifting the cover of the hive, to examine the combs in the top super, whether or not another super is needed. This saves the time ordinarily taken in lifting off the filled and partly filled supers to examine the combs in the super in the bottom of the pile, or the last one given. Of course, the filled and partly filled supers have to be lifted back onto the hive again and that takes more time.

2. Supering on top reduces labor. It is more than labor. It is real back-breaking work—lifting these heavy supers off and on.

3. Supering on top avoids much confusion of bees in the apiary. Bees become confused when they return from the fields loaded with nectar to find their hives torn down. The bees in their confusion may enter other hives. This may cause the bees to be ill-natured. During a good honey flow bees do not like to be interrupted in their work.

4. Supering on top does not disrupt the activities of the bees within the hives. The other or old method of supering, viz., placing the fresh super between the brood chamber and the remainder of the supers, may have a tendency to slow up, to some extent, the normal activities within the hive. It must take the bees some little time to become fully adjusted to the position of the combs in the super last given and to resume normal work after the remainder of the supers are put back in place. It would be interesting to actually know how much honey, if any, is lost during a heavy honey flow, due to disrupting the normal activities of the bees by the old method of supering.

5. Another advantage in supering on top is that the combs are likely to be well filled. With the other method of supering

there may be too many partly filled combs. With supering on top there are very few if any partly filled combs. The bees fill only as many combs as are necessary to hold the crop. This means less labor of handling combs containing honey and therefore greater speed in extracting. This means a considerable saving in labor.

The main thing to be kept in mind in carrying out the method of supering on top is to give each colony plenty of supers in advance of the time they are actually needed. It is safe to say that tons of honey are lost each season because beekeepers fail to put on supers in time. A powerful colony needs ample comb space for storage and for evaporating the water from nectar. If a beekeeper has three or four extracting supers ready for each hive at the beginning of a good honey flow, it may, if the distance to the outyard is great, do no harm to put on two or three supers, or perhaps four at one time. If the bees need the storage space they will take it. If they don't need it, the combs will be with the bees and will be kept free from the ravages of the wax moth.

Those who have not tried the system of supering on top may object to it on the ground that the bees are forced to carry the nectar from the entrance of the hive to the top super, thus imposing a hardship on them. As a matter of fact, it seems to make little if any difference to the bees where the newest or last super given, is placed. If the bees need the storage space they will enter the super readily, even though it is on top of the pile.

The question may be asked "Why does this new method of supering work?" In attempting to answer this question it seems reasonable to assume that a colony of bees prefers to extend its activities naturally and gradually, in occupying more comb space as it is needed. This is what actually occurs in the crevice of a rock, or a bee tree occupied by a colony of honey bees.

Then, too, the heat within a beehive is greater near the top of the hive. This means that comb building, also the evaporation of the moisture from nectar will proceed just as well, or perhaps better, with the method of supering on top than would be the case with the old method of supering.

The work of comb building and the storing of nectar takes a large percentage of bees away from the brood chamber to the top supers, and thus a congested condition in the brood chamber and in the bottom supers will probably be relieved. Swarming is not likely to occur with the new method of supering provided supers are given in ample time and enough comb space is provided to avoid congestion within the hives.

The main advantages in top supering are that it is simple, it is economical because it saves labor and time, and it permits colonies of bees to extend their activities gradually and naturally over the combs that are needed for the storage of surplus honey.

For supering in producing comb honey, see Comb Honey, to Produce.

SWARMING.—The term "swarming" is applied to the act of a family of bees leaving their home to establish a new home elsewhere. In the broadest sense the term includes not only reproduction of colonies by normal swarming when the colony divides itself by part of the bees leaving but also swarming out from various causes when the entire colony migrates. The term is sometimes applied to the division of colonies as in artificial swarming. Usually the term swarming means the issuing of normal swarms when the colony is prosperous, only a part of the bees leaving the hives. Normal swarming is, therefore, a division of the colony for the purpose of reproduction.

The term "swarming-out" is usually applied to the migration of the entire colony as in the case of lack of food (hunger swarms), recently hived swarms that are dissatisfied, swarms that leave because of American foulbrood, and small nuclei that swarm out with the young queen when she takes her mating flight or because the little colony is dissatisfied.

The migrating family of bees is called a swarm, though this term is sometimes applied to the colony after it has established itself in its new home, to distinguish the new colony from the parent colony. In a strict sense the term swarm applies only during migration. As soon as a swarm establishes itself in its new home it is called a colony.

Chain of Events Leading up to Swarming

A colony of bees that is normal and prosperous increases its brood in the spring as its adult population increases, either until all the available brood-comb

is occupied or until the queen reaches the limit of her capacity in egg-laying. Early in the spring only worker brood is reared, but when the colony becomes stronger the rearing of drone brood is begun, thus providing for male bees in anticipation of swarming. Finally when the brood-chamber becomes crowded with emerging and recently emerged young bees and the combs are well filled with brood, several queen-cells may be started. When eggs are placed in these partially built queen-cells the colony has then taken definite steps in preparation for swarming, the swarm usually issuing eight or nine days later at about the time the more advanced queen-cells are sealed. The exact time of the issuing of the swarm depends to some extent upon the weather. Sometimes it must be postponed a few days on account of rain, and sometimes during hot weather the swarm will issue before any of the queen-cells are sealed, especially if the bees are Italians. Normal swarms usually issue between 10 a. m. and 2 p. m. In hot weather most of the swarming is over by noon.

Symptoms of Swarming

In their natural state and when neglected or poorly managed, the bees usually slow down in their work after queen-cells have been started in preparation for swarming, especially during a few days just previous to the time the swarm issues. The field workers in increasing numbers stay in the hive instead of working in the fields, bringing about a crowded condition sometimes resulting in a great cluster of bees hanging on the outside of the hive. This clustering on the outside of the hive was formerly considered a symptom of swarming provided it occurred during a honey flow, but it is by no means a reliable symptom. Clustering out during hot weather when there is a dearth of nectar is quite another thing and has nothing to do with swarming.

A more reliable symptom that the colony is preparing to swarm is a lack of the usual flight at the entrance, due to many of the field bees' staying at home. When this is noticeable, by looking into the supers it will be noted that they are crowded with bees, sometimes wedged into every nook and corner, this being quite unlike the normal condition in the supers. These idle bees are usually filled with honey, which makes them appear unusually large because of their distended abdomens. These conditions, when present during a honey flow, are practically a sure indication that the colony is preparing to swarm. However, in well-managed colonies this slowing-down of field work does not always occur, but little if any difference in the work being noticeable even on the day the swarm issues.

The only certain indication of swarming is the presence of queen-cells containing eggs or larvae during the swarming season. By noting the advancement of the queen-cells it is often possible to predict on what day the swarm will issue. Queen-cells built under the swarming impulse are sometimes called "swarming cells" to distinguish them from queen-cells built at other times to supersede the old queen. (See How to Distinguish Between Swarming Cells and Supersedure Cells further on under this head; also see Supersedure.)

The Prime Swarm

When the first swarm issues a varying proportion of the adult bees, together with the old queen, fly from the hive, leaving behind many adult worker bees, a large number of unemerged young bees, and several unemerged young queens. This is called the prime swarm to distinguish it from after-swarms which may issue from the parent hive about a week later. The number of bees that accompany the swarm depends somewhat upon the weather. Swarms are usually smaller when the weather is cool, and larger when the weather is hot.

Just why some go and others stay is not known. While the divisions may be somewhat according to age, there is apparently no fixed rule for this. Many of the older field bees remain in the parent colony, and often during hot weather many bees too young to fly attempt to accompany the swarm. Some of the drones accompany the swarm, but many of them remain in the hive. Sometimes three-fourths or more of the bees go with the swarm. Swarms from strong colonies sometimes weigh 10 pounds or more, but usually they weigh less.

Sometimes the queen leaves the hive among the first, but oftener she leaves after half or more of the swarming bees have left, and sometimes she is among the last to leave. Occasionally she does not find her way out of the hive at all,

in which case the swarm will return unless it unites with another swarm having a queen.

As the swarming bees rush from the hive they circle about in the air, covering a wide area at first but gradually drawing together and finally clustering on some convenient support such as the limb of a tree. After an interval, usually varying from about 15 minutes to several hours, or even in exceptional cases a day or more, they break cluster and fly away to find a new home. Occasionally a swarm will leave the hive and go directly to a hollow tree or empty hive, apparently having previously selected their shortly before a swarm came and entered, and the remarkable directness of the flight of the swarm from the hive or clustering place to a hollow tree or other suitable abode would be difficult to explain in any other way. (See Absconding Swarms, page 11.) The advice is usually given to hive the swarm as soon as it has clustered and move it away so returning scouts can not lead the swarm away. Sometimes swarms travel several miles before finding a new home clustering and breaking cluster several times while on the way.

Swarming bees are usually good-natured and pay little if any attention to the

Swarming bees are usually good natured.

new home; but, as a rule, they cluster near the apiary before going away.

There is considerable evidence indicating that scouts are sent out to find a new home either previous to swarming or while the swarm is clustered, or both. Many have noticed a few bees working around a hollow tree or an empty hive beekeeper, even when he walks about in the midst of the circling bees. Sometimes, however, after they have been clustered for some time they will sting viciously when disturbed, especially if they have remained clustered for several hours or overnight. There is also considerable difference in the way the bees behave, de-

pending upon the weather, so it is not safe to assume that swarming bees are always good-natured.

Before leaving their hive, the swarming bees fill themselves with honey, taking a supply of food with them when seeking a new home. They are, therefore, prepared to begin building comb in their new home almost immediately. Within a few days the newly formed colony becomes well established. The queen begins to lay in the newly-built combs before the cells are fully drawn out, and, if nectar is abundant, comb-building and the storing of honey are carried on rapidly.

During the first few days the bees build only worker comb; but usually, after building the equivalent of four to six standard frames of comb, they begin to build drone-sized cells. If the queen is old they usually begin to build drone-cells earlier than if the queen is young and vigorous. Apparently when the bees build worker comb faster than the queen can fill it with eggs, they begin building the larger cells, these being for the storage of honey. If a swarm is hived on one or two empty combs, the remainder of the hive being vacant, the bees begin at once building drone-sized cells.

After-Swarms

About a week after the prime swarm issues the first of the young queens emerges from her cell if the swarm issues at the time the first queen-cells are sealed. Instead of destroying the other young queens and permitting this first-emerged young queen to become the new mother of the colony, the bees, if left alone, usually swarm again. This after-swarm is accompanied by the first young queen. If the beekeeper does not interfere other after-swarms usually issue, with an interval of one or two days between, each being smaller than the preceding until there are no longer enough bees left to divide among the remaining young queens.

Apparently after the first young queen emerges the bees hold the other young queens prisoners within their cells until the first after-swarm issues. If the hive is opened just before the issuing of the first after-swarm, usually but one of the queen-cells will be found vacant; but the disturbance of opening the hive apparently confuses the workers so they cease guarding the unemerged queens, and several may emerge at once while the hive is open. When subsequent after-swarms issue there may be several young queens at large in the hive, and sometimes several of them accompany the swarm.

When the first young queen emerges she begins "piping" (see Queen-rearing, subhead Queen's Voices), and her rivals confined in their cells answer her call. This "piping" can best be heard by placing the ear against the side of the hive in the evening. Usually it may be expected about a week after the issuing of the prime swarm. When "piping" is heard in the evening an after-swarm may be expected the next day unless the weather is prohibitive. If other after-swarms are to follow, the piping may again be heard after one or more after-swarms have issued. Each after-swarm seeks a new home where it establishes itself as a new colony. If sufficient food is available these little colonies may build up to normal strength for winter; but too often they are not able to do so, for sometimes the last of the after-swarms to issue contain less than a pint of bees.

When further swarming is given up, sometimes after the casting of from two to five after-swarms, all but one of the remaining young queens are killed. About 10 days after emergence the surviving young queen usually begins to lay, and the parent colony again takes up brood-rearing. This makes an interval of about 16 days when no eggs are laid in the parent colony. Sometimes the young queen is lost on her mating flight and the colony, having no young brood from which to rear another, is hopelessly queenless. Such colonies dwindle and finally die unless the beekeeper supplies a queen or brood. (See After-swarms.)

Prime Swarms with a Young Queen

Conditions somewhat similar to those in after-swarming are sometimes brought about without the issuing of a normal prime swarm accompanied by the old queen. If the old queen fails or is removed from the hive by the beekeeper or is lost through accident, the bees proceed to rear another. Instead of rearing but one queen they build several queen-cells, and if the colony is prosperous at the time the first one of these young queens emerges, and especially if nectar is abundant in the fields, the bees usually swarm instead of permitting the young queen to destroy the others. In this case the first swarm is accompanied by a virgin queen,

and after-swarming follows in one or two days instead of after an interval of a week or more as when the prime swarm is accompanied by the old queen in the normal way. In such cases the first swarm, though accompanied by a virgin queen, may be as large as the normal prime swarm.

It will be noted that after-swarming is a result of a plurality of young queens and that in nature the division is often carried too far for safety, since many of these little swarms are doomed to perish the following winter, and sometimes the parent colony is so depleted by excessive after-swarming that it fails to store enough honey for winter. Obviously the beekeeper can not afford to permit the bees to carry out their program of swarming in their own way as described above. He therefore manages to prevent after-swarming (see After-swarming) and also as far as practicable, to eliminate all swarming.

The Swarming Season

Normal swarming takes place during a more or less well-defined period called the "swarming season." In some localities there are two or more swarming seasons during the year, but usually most of the swarming takes place within from two to six weeks. The period for any locality comes at about the time the colony has the greatest amount of brood and emerging young bees in the spring. It may begin as early as March in the extreme South, while in the far North it may not begin until July. If the colonies are not strong enough and prosperous enough to build up to great strength early in the spring, the swarming season may come later after the colonies have built up to swarming strength.

In localities where there is an early honey flow in the spring followed by a fall honey flow, there may be a secondary swarming season during the fall honey flow. For example, in some parts of the buckwheat region the bees will swarm in May or June when sufficient nectar is available from fruit bloom and clover, then again in August or even in September during the fall honey flow. Where the early and late honey flows overlap, forming a long continuous honey flow, the swarming season may be greatly prolonged, especially if the bees were not uniform in strength in the spring, so that some become strong enough to swarm early while others reach swarming strength later. In any case there is less tendency to swarm in late summer or early fall than in the spring.

Swarming does not often occur after the close of the honey flow. If preparations for swarming have been delayed until near the close of the honey flow, the bees often tear down the queen-cells and give up swarming as soon as nectar becomes scarce. On the other hand, early in the spring colonies often swarm even when not enough nectar is available to keep them from starving unless fed by the beekeeper. The instinct to swarm is much stronger when the colony first reaches swarming strength than afterwards.

Economic Loss from Swarming

In the days of the box hive when honey was obtained by killing some of the colonies in the fall, swarming was considered desirable because in this way the number of colonies for slaughter was increased. Modern beekeeping has entirely reversed this view, swarming now being considered extremely undesirable. Up-to-date beekeepers are careful to reduce swarming to the greatest possible degree, and, where it can be done profitably, prevent it entirely. Increase can be made to better advantage artificially (see Artificial Swarming and Dividing), for this can be done at the convenience of the beekeeper instead of watching the apiary every day during the swarming season in order to take care of issuing swarms.

Where swarming is not controlled by the beekeeper, the loss from absconding swarms and from the interruption in the work of the bees often causes the loss of good crops of honey which might otherwise have been obtained. In those localities where swarming occurs during the honey flow, as in most northern locations, swarming, if uncontrolled, causes great loss, often preventing the bees from storing any surplus at all; for if colonies are permitted to divide their working force into two, three, or more parts during the honey flow, the division usually marks the end of storing honey in the supers for the season unless the honey flow is unusually long—long enough to permit each division to build up strong enough to work in the supers.

In some regions, as in parts of the South, and in some of the western states, the swarming season for well-wintered

colonies comes six or eight weeks before the main honey flow. In such cases if after-swarming is prevented and both the swarm and the parent colony have sufficient stores to build up to full strength again before the honey flow, the division is advantageous; but, even in such cases, it is usually less trouble for the beekeepers to make the division.

Beekeepers' Preparation for Swarming

The beekeepers should have on hand some extra hives containing empty combs or frames with full sheets of foundation for hiving swarms that issue, unless he expects to practice the requeening method, mentioned later, for swarm-control. These should be prepared in advance of the swarming season, so that it will not be necessary to nail up the hives and put the sheets of foundation in the frames after the swarm has issued. It is not necessary to have as many empty hives as there are colonies in the apiary, for under good management only a part of the colonies will swarm even during a season when the bees are much given to swarming. Some make it a rule to have half as many empty hives as there are colonies of bees if considerable increase is desired, but the beekeeper who has several hundred colonies and does not care for further increase may provide only one extra hive for every four or five colonies.

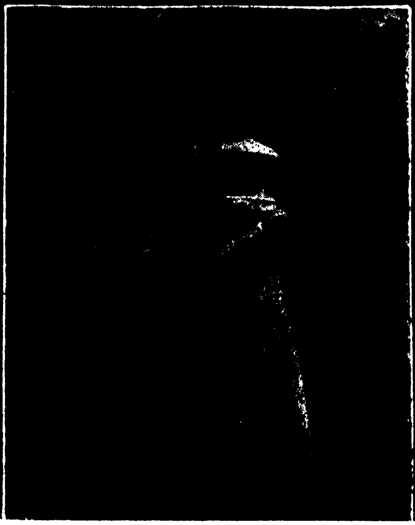
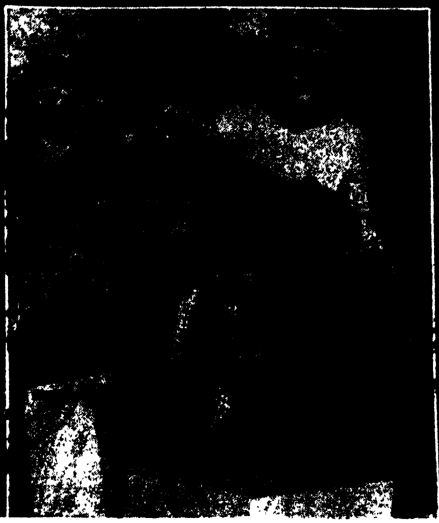
As a preventive measure for swarming as well as for the purpose of securing as much honey as possible, an abundance of supers* should be provided so that the bees can be given all of the super room they will need during the season. In the production of extracted honey it is important to have plenty of empty combs for the extracting-supers. If these are not to be had, the extracting-supers should be supplied with frames containing full sheets of foundation. Empty combs are not only better for the purpose of producing the largest possible crop of extracted honey, but at the same time they are very much better so far as the prevention of swarming is concerned. For comb-honey production the comb-honey supers should be supplied with sections containing sheets of foundation which nearly fill the sections. This not only results in more surplus honey as well as honey of a finer appearance, but also helps to reduce swarming, inasmuch as combs are built more rapidly when full sheets of foundation are used than when narrow strips only are used.

Sometime before the swarming season, preferably during the fruit-bloom period, the queen of each colony should be found and her wings clipped, as explained under Queens. Most honey-producers today consider this important, because it is much easier to handle any swarms and because it prevents the escape of the swarms if the beekeeper is absent. While some of the queens may be lost if swarms issue while the beekeeper is away, it is better to lose the queen than to lose both the swarm and queen. Of course, if a swarm issues during the beekeeper's absence and loses its queen because she is clipped, the swarm having returned to the hive, it is necessary for the beekeeper to examine the bees carefully within a week to destroy all but one of the queen-cells before any of the young queens can emerge, since otherwise a swarm would issue accompanied by a young queen. If the queen's wings are clipped during the early season it is not difficult to find her, because there are not so many bees in the hives.

During recent years beekeepers have made such great progress in the prevention of swarming that some find it does not pay to clip the wings of the queen because only a few swarms ever issue. In some localities where swarming is easily prevented it does seem useless to find and clip the queens every spring when practically none of them ever attempt to swarm; but in locations where swarming is troublesome the beekeeper will feel much safer, especially in out-apiary work, if all of the queens are clipped.

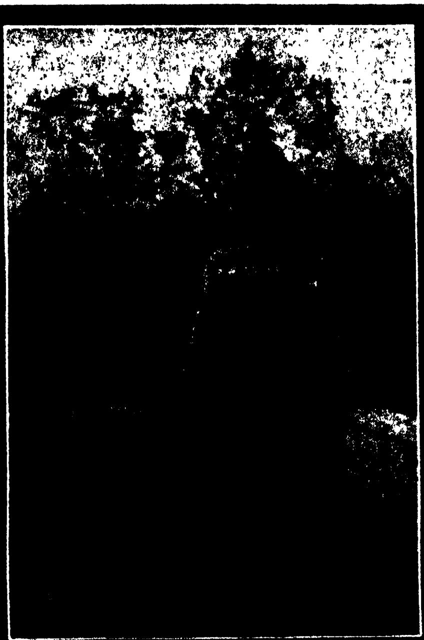
Some object to clipping the queens on the ground of the difficulty in finding them, while others are timid about picking up the queen to clip her wings, fearing they might injure her. Again, there are cases where the combs can not be taken out of the hives to find the queen on account of being built crosswise. In all such cases the queen-and-drone trap, described under Drones, can be used. This does practically the same thing as clipping the queen's wings but goes a step further since it catches the queen and holds her a prisoner until the beekeeper can take care of the swarm. But any queen trap over the entrance interferes with proper circulation of air through the

*By supers are meant half or full depth hives containing empty combs, frames of combs, foundation, or sections containing starters. See Beginning with Bees.

HIVING SWARMS VARIOUS WAYS

Upper left: Mrs. E. O. Leas, Winchester, Ind., takes a fine swarm from a tree. Upper right: Miss Louise Stoelting, Council Bluffs, Iowa, refuses to wear a veil while hiving a swarm in her brother's apiary. Lower left: E. L. Kinkade, Graysville, Ohio, lets them settle on his hat, then walks to the hive; but in the next picture at the right he carries one in the orthodox manner.




entrance. Lack of ventilation encourages swarming. Better transfer the bees on to good combs and open the entrance to full width.

How to Hive a Swarm

When the queen's wings are clipped or when the queen-and-drone trap is used, hiving swarms is a simple matter. If the queen is clipped she can usually be found readily on the ground in front of the hive and put into a cage. If the queen-and-drone trap is used the queen is automatically caught in the upper part of the trap. The parent hive is then moved away while the swarm is out and a new one put in its place, so that the bees upon missing their queen will return and enter the new hive. In many cases the swarm returns without clustering, but it may cluster and remain clustered for a half hour or more before returning. In the meantime the cage containing the queen is thrust into the entrance of the new hive, or if a trap is used it is transferred to the new hive and the slide is pulled out to let her go below. (See After-swarming.)

While the author does not recommend that swarms be permitted to issue without either the queens' wings being clipped or the use of the queen-and-drone trap, many swarms are permitted to issue in this way, therefore directions are here given for hiving such swarms.

Ringing Bells to Bring Down Swarms of No Avail

When a swarm issues it is not necessary to ring bells or beat tin pans as was formerly done in order to induce the bees to settle. So far as can be determined, such a procedure has no effect whatever upon the swarming bees. In most cases, after circling about for a short time the bees will form a cluster without any help on the part of the beekeeper. It sometimes helps to use a spray pump or a hose to throw water among the flying bees to prevent two swarms from uniting while in the air or to drive the swarming bees away from the tall trees for the purpose of inducing them to cluster in a more convenient place. Throwing water among the flying bees is also useful to stop a swarm that is leaving for the woods. A good drenching may cause them to cluster instead of absconding. Ordinarily, however, nothing need be done until the bees have clustered.

Hiving the Swarm

If they cluster on a limb of a tree or bush where they can be conveniently reached, one of the simplest ways of hiving them is to cut off the limb above the clustered bees and carry it to the hive. Care must be taken in cutting off the limb not to jar it or the bees may drop off, take wing, and cluster elsewhere. When the swarm is carried to the hive the limb can be laid down gently in front of the hive, so that the bees will be as near as possible to the entrance. Some of the bees are then gently pushed into the entrance by means of a twig so that they will start running in. As soon as they begin to run into the hive they set up a call for their comrades to follow, this probably being done by odor. When the bees are running in rapidly the limb can be shaken to dislodge the remainder of the bees if it is desirable to hasten matters, but if there is no hurry about hiving the swarm on account of the possibility of other swarms issuing and uniting with it, the bees can be left to take their time in crawling into the hive.

If the bees cluster on a limb that can not well be spared or that is too large to cut off, they can be shaken or brushed from the limb into a bushel basket, then carried to the hive and poured out in front of it, when they should immediately begin to run into the hive. When bees are poured out from a basket in this way some of them may start to run in the wrong direction, but they can be guided toward the entrance by means of a brush. It is well to place a wide board in front of the hive on which to pour the swarm when hived in this way.

Sometimes it is more convenient to carry the hive to the cluster than to carry the cluster to the hive. In such cases the hive should be carried to its permanent location as soon as the bees have entered. Where there are many colonies in the apiary swarms should be hived as quickly as possible or other swarms may issue, and several of them unite if not cared for promptly.

If a swarm clusters on a limb too high to be reached from the ground, it is sometimes necessary to use a ladder to reach them. If the bees cluster on a limb too large to be cut or shaken, part of them can sometimes be scooped up in a dipper and poured out at the entrance

of the hive. In such cases it is well to put the hive on a stepladder or a box so its entrance will be against the cluster. By scooping up some of the bees or by brushing them so they will fall upon the alighting-board of the hive, they can be induced to enter and set up a call for their comrades to follow.

How to Get a Swarm from an Inaccessible Limb

Sometimes a swarm will alight upon a limb beyond the reach of any ladder. Possibly, also, the limb upon which the bees are clustered is so far out from the body of the tree that it would not sustain the weight of any one climbing after them. Such a swarm can usually be reached in the following manner: A stone about as large as the single fist is tied at the end of a good line. If one is not a good thrower himself he can get some boy who is a good ballplayer to perform the throwing act. He should uncoil a considerable quantity of the line, and then throw the stone into a crotch if one is near the swarm. If he is lucky enough to land the stone in the crotch, he should draw gently on the line until the stone catches in the fork. One quick jerk will dislodge the bees, and after that the limb should be kept in a tremble until the bees cluster on some other spot, which they will do presently if the limb is kept agitated for five or ten minutes. They may cluster higher up, but the probabilities are they will seek some other spot more accessible.

Some throw a line over a limb above the swarm and then use the line to draw a light rope over the limb to which a hive or light box can be attached. If the hive or box can be brought up close to the cluster and the limb shaken to dislodge the bees, so that many of them will fall into it, the entire swarm may then enter, when it can easily be lowered to the ground.

How to Bring a Swarm Home from a Distance

A swarm will sometimes escape and be traced a mile or so from the beeyard. At other times some one will report that a swarm of bees is hanging to one of his trees, and that, if the beeman will come and hive them, he can have them. A good swarm is sometimes worth going after; but how shall it be brought back with the least expenditure of time when bees are swarming at home? A boy equipped with two cheese-cloth bags, a pair of pruning-shears, and a smoker can be sent in the family car. On arrival the bag is quietly slipped around the swarm of bees, clustered on a limb of a tree, and

A bag made of cheese-cloth is slipped over the cluster in such a manner that most of the bees can be dislodged into it.

the bag tied. The limb is then cut with the pruning-shears, when the bag and all are put into the car and taken home. If the limb can not be cut off, most of the bees can be shaken or brushed into one of the bags, when it should be tied shut and hung in a convenient place, so that the rest of the bees will cluster on the outside of it. The second bag is then slipped over the first and tied, when it is ready to take home.

Swarms Uniting in the Air

Sometimes when the swarming-note is heard in the apiary other colonies seem to catch the excitement and issue one after another while the first is still in

the air. Of course, if the wings of the queens are not clipped they will unite in one, and as many as a dozen have been known to come out in this way and go to the woods with a stray virgin before anything could be done to stop them. If for no other reason, the wings of all queens should be clipped.

When the queens are clipped, they can be caught and caged as the swarms issue; then the large cluster of bees can be divided into as many parts as there are queens and hived in the ordinary way, each division being given one of the queens.

After most of the bees are confined in the bag it is hung where the remaining bees will cluster on it then a second bag is slipped over all when the swarm is ready to be taken home.

When the bees are all confined within the outer bag the swarm can be transported many miles to be hived.

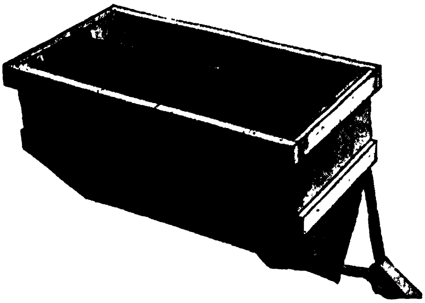
Some Handy Swarming Devices

Almost every apiarist has his own peculiar notion as to how a swarming device should be constructed. Some of these implements are very ingenious, and of valuable assistance during the swarming season. Their particular use is to remove a swarm after it has clustered, and place it in the hive. The first one to which attention is called, not because it is the best but because it is the simplest, is a sort of butterfly-catcher.

The hoop is made of band iron, about 20 inches in diameter. The ends are secured, as shown, to a suitable pole. When the bag is attached to the hoop, it is designed to be put up under the swarm, and the hoop is then made to cut off the cluster so that the bees will fall into the bag. It is then turned edgewise, so as to confine them while being taken down and carried to the hive. It may be necessary to hold the bag in the air to catch the flying bees. These will shortly cluster on the outside. As the bag is made of cheese-cloth, the bees inside have plenty of air. To empty the bees out, turn the bag inside out.

A simple but useful swarm-catcher.

Another type of swarm-catcher is a wire-cloth basket mounted on a pole in such a manner that it hangs always in an upright position. It is made to hold an empty comb or a frame of brood to induce the bees to cluster in it if the cluster is located where it can not readily be

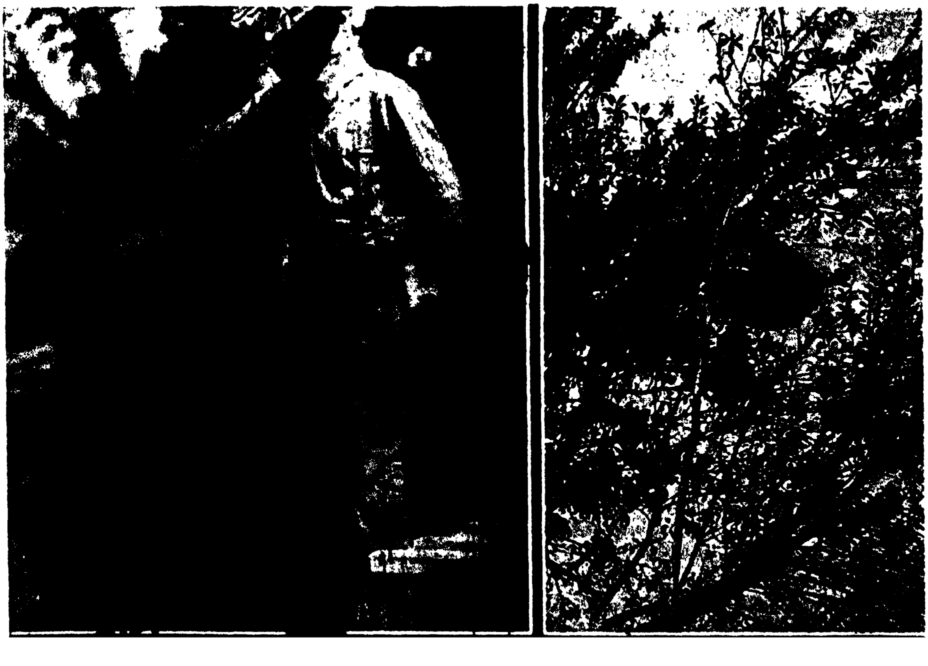


A wire-cloth basket attached to a long pole for taking swarms from trees.

taken down by jarring the bees into the basket. If only a part of the bees can be gotten into the basket, by placing an empty comb or a comb of brood into it and locating the basket against the cluster, the remaining bees will gradually crawl into it, when the entire swarm can be taken down and carried to the hive. Some make a light wooden box which is fastened to the end of a pole, which can be used in the same way.

In the absence of any special tools or appliances one can extemporize in a very few minutes a swarm-catching device out of the ordinary material on a farm. A small sapling, long and slender, is cut. All the branches are trimmed off, care being taken to leave a fork or crotch in the end. This extemporized swarming-pole should be generally from 12 to 15 feet long. A common bushel basket is hooked into the fork at the end of the pole.

After being hooked on to the end of the pole, the basket is elevated to a point just below where the swarm is hanging on the tree. It is gradually pushed up until the swarm is nicely placed therein. The pole is given a sharp push upward, care being taken not to unhook the basket. This sudden jar will dislodge the swarm; and before the bees have an opportunity to take wing, the basket is lowered and unhooked from the end of the pole. It may now be dumped in front of the hive. In all probability a few more bees may cluster back on the old spot. If so, the operation is repeated, after which the second bunch of bees is placed where the first was dumped.



S. D. Chapman, of near Macedonia, Mich., and his method of hiving swarms with a forked pole and a bushel basket.

The Swarm-hiving Hook

With most of the hiving devices a hiving-hook can be used to considerable advantage at times. It is simply an iron hook mounted on the end of a long pole, and somewhat resembling a shepherd's crook. One of the hiving-devices is passed beneath the swarm. This hook can be used to reach over, grasp the limb on which the swarm is clustered, and by one or two smart jerks jar the bees into the basket, bag, or box.

Spray Pump for Driving Swarms While in the Air

A swarm of bees in the air with a queen that might otherwise circle about for fifteen or twenty minutes can usually be made to cluster in from two to five minutes by a spray pump. Whether the fine particles of water dampen the wings, and so impede their flight, or cause the bees to think it is raining, or both, and that they better cluster at once, can not be proved; but certainly the spray has a very decided effect. One who becomes moderately expert will be able not only to make the bees settle but to compel them to cluster on some point easily accessible to any of the ordinary hiving-devices just described. Occasionally a swarm will make for the top of a tall tree. With a pump they can be headed off, causing them to settle on a lower branch. Even when a swarm is clustered twenty or thirty feet from the ground, by adjusting the stream nozzle and letting it play directly on the swarm, it can many times be dislodged, thus causing the bees to take wing and finally settle again upon a lower limb or bush. Again, several swarms may come out simultaneously, and two or more attempt to cluster together. By the timely use of the spray, each swarm can be kept separate by dampening the wings of the stragglers of the two swarms about to come together. A good many times a swarm that is about to abscond can be headed off and made to cluster, but the use of a spray pump and these other devices can be avoided by clipping the wings of all queens.

The Swarm Catcher

A large wire cage that comes down over the whole hive can be set down over the hive that is casting a swarm. As soon as the bees are all out, the cage is lifted gently, and carried to the hive where it is proposed to dump the swarm. The cage is held squarely over the prepared hive with its cover off, and given one quick jolt. This will dislodge the bees so that most of them will land in and around the hive. As soon as they have settled, the cage is removed and the cover put on the hive. These swarm-catchers are especially useful when several swarms issue at about the same time. If one swarm is already in the air and another starts to come out, a cage can be set over its hive, thus preventing a general mix-up. (See page 633.)

The Automatic Hiving of Swarms

Several devices have been made for hiving swarms automatically, but most of them have proved to be more or less a failure. The general plan contemplates some scheme having an empty hive placed near the colony expected to swarm. This empty hive may be alongside, in front of, above, or below the other one. In the case of the first-mentioned plan, an entrance-guard is placed in front of each hive; and connecting the two is a tube of wire cloth or perforated zinc. When the swarm comes forth, the queen, finding herself barred by the perforated metal, runs along until she finds the tube communicating with the entrance-guard of the other hive. In this tube she runs up against a bee-escape or wire-cloth cone. She passes this, but, being unable to return, is compelled to enter the entrance-guard of the new hive. Upon discovering that the queen is not with them, the bees rush back to the old stand; a part of them find the queen in front of the new hive, enter with the queen, and "set up housekeeping." But the plan often fails because the majority fail to find her and re-enter the parent colony. However, when this occurs, the beekeeper, on discovering that the bees have swarmed, can exchange places with the two hives and thus cause most of the bees to enter the new hive.

Where to Locate Newly-hived Swarms

Wherever the swarming season comes on during the main honey flow, as in the clover region of the northern states and the orange region of southern California, the early-hived swarms should be located on the old stand, the old hive being placed close to one side if comb honey is being produced, or placed on top of the supers if extracted honey is being produced, in order to keep the working force of the colony together in the same hive while the honey flow lasts. (See After-

swarming, also Artificial Swarming.) In comb-honey production the parent hive should be moved away a week after hiving the swarm in order to draw away the young bees that have learned to fly in the meantime, adding them to the colony on the old stand, thus strengthening the colony that is working in the supers and at the same time preventing after-swarming.

In locations where the swarming season occurs several weeks previous to the main honey flow, as in Texas, so that both the parent colony and the swarm can be built up to full gathering strength before the honey flow, it is not necessary to carry out this procedure, but all after-swarming should be prevented either by moving away the parent colony just before the young queens emerge or by killing all but one of the queen-cells. If after-swarms were permitted to issue the parent colony would be depleted too much to build up before the honey flow, and the after-swarms would be too small to be productive.

What to Use in the New Hive When Hiving Swarms

For extracted-honey production either empty combs or full sheets of foundation may be used in the new brood-chamber when hiving swarms. When there are not enough empty combs for a full set in each hive, usually a few empty combs are used and the remaining spaces filled out with frames containing full sheets of foundation. Sometimes only one empty comb is used, the rest of the frames containing full sheets of foundation. This is better than to use a full set of frames of foundation.

For comb-honey production it is not advisable to use a full set of empty combs in the new brood-chamber when hiving swarms, for when this is done the bees are inclined to store their honey in these combs, neglecting the work in the supers. This is especially true for colonies that are of only medium strength. For this reason it is better to use full sheets of foundation in the brood-chamber when hiving swarms in comb-honey production. When this is done at least one empty comb should be used to reduce the tendency to swarm out, as sometimes occurs when frames of foundation exclusively are used in the new brood-chamber. If no empty combs are available for this purpose, it is well to place an empty hive-body under the new brood-chamber for two or three days if the bees are inclined to swarm out.

At one time it was thought best to use only narrow strips of foundation in the frames in the new brood-chamber, on the theory that the bees will then be compelled to store their honey in the supers on account of the greater length of time necessary to build comb in the brood-chamber when the narrow strips of foundation only are used. Under some conditions this plan gives excellent results in comb-honey production; but it is open to the serious objection that entirely too much drone comb is built in the brood frames. There is a tendency also to store pollen in the sections during the first few days after being hived, since there is no comb in the brood-chamber in which to store pollen. This can be overcome by using one empty comb in the new brood-chamber to catch the incoming pollen but this would, to a certain extent, defeat the purpose of the use of narrow strips of foundation only, for it would afford a place for immediate storage of nectar in the brood-chamber instead of in the sections. Another objection to the use of empty combs in the new brood-chamber in connection with frames containing only narrow strips of foundation is that the bees would begin the building of drone combs just that much sooner. Usually the bees will build the equivalent of four or five standard frames of worker comb before they begin building drone comb. For this reason some beekeepers contract the new brood-chamber to five or six standard frames when hiving swarms, the remaining space being filled with thick division-boards. But this plan has been largely abandoned because it leaves the colony destitute of honey and greatly weakened at the end of the season. Those who use it usually unite the swarm with the parent colony in the fall.

It is sometimes convenient to hive swarms on combs containing honey. When combs of honey which are mostly unsealed are used the bees will begin to transfer the honey into the supers almost immediately after being hived; but if combs of sealed honey are used the bees will often sulk or work with less vigor in the supers, apparently objecting to uncapping and transferring the sealed honey to the supers. It is sometimes a

good plan in comb-honey production to have frames of foundation drawn out in the second story of the strongest colonies at the very beginning of the honey flow to hold down swarming, and then use these newly built combs containing unsealed honey on which to hive swarms.

Using the Hive of a Parent Colony for Swarms

If the beekeeper runs out of hives during the swarming season he can utilize the hive of a parent colony, choosing one that swarmed ten days or more previously. In this case the bees in the parent colony can be shaken from their combs in front of the recently hived swarm; then this hive, together with the comb containing now only sealed brood, can be used for hiving another swarm. When such combs are used there are so few vacant cells that the bees will not neglect super work on account of the empty combs below, but the few cells that are vacant will soon be occupied by eggs which the queen will lay soon after the swarm is hived. As the remaining brood emerges the vacated cells are usually prepared for eggs until toward the close of the season, when the bees will put in more honey.

When either narrow strips of foundation or full sheets of foundation are used in the new brood-chamber a queen-excluder should be placed between the brood-chamber and the supers at the time of hiving the swarm, because without it the queen would probably establish a brood-nest in the supers.

Swarming-out

Sometimes newly hived swarms "swarm out," deserting their new hive and absconding if the queen is not clipped. They may do this within an hour or two after being hived or the next day and sometimes even as late as the third day after being hived. Swarming out may occur either with natural swarms or artificial swarms. The tendency for newly hived swarms to abscond is greater some seasons than others. This contingency is apparently a result of a lack of room in the new hive or of discomfort from some other cause, though sometimes newly-hived swarms will leave the hive when there is no apparent reason.

Swarming out can be prevented, or at least greatly reduced, by placing an empty hive-body below the new brood-chamber for two or three days, by providing ample ventilation and shade for the new hive at the time of hiving the swarm, and by using one or more empty brood combs in the new brood-chamber instead of frames of foundation exclusively.

If the queen is clipped, colonies that swarm out can not abscond unless by chance they unite with another swarm that has a queen able to fly that happens to be out at the same time. When bees swarm out they can be handled in the same manner as a swarm with a clipped queen (see directions under After-swarming), by simply caging the queen, thrusting the cage into the entrance, and waiting for the swarm to return. An empty hive-body should be put under the brood-chamber and the hive should be shaded if these things were not done when the swarm was hived. Sometimes it is not necessary to make any change of conditions to induce the bees to stay after they have swarmed out.

Occasionally when bees swarm out they become demoralized and do not all return to their own hive, some going into adjacent hives. When bees swarm out in the absence of the beekeeper the queen is liable to be lost by entering another hive. If the queen is not clipped it is well to place an entrance guard or a queen-and-drone trap over the entrance for a few days if the bees are inclined to swarm out. This will prevent the loss of the queen, and the bees will usually return to their own hive.

THE CAUSE OF SWARMING

Since swarming is the natural method of reproduction of colonies, upon which in their natural state the existence of the species depends, beekeepers are willing to accept the deeply seated reproductive instinct as the fundamental cause of swarming, but they want to know just what calls forth this instinct at certain times and why it is apparently dormant at other times. It is well known that some colonies go through the season piling up a large surplus of honey, apparently without a thought of swarming, while other colonies in the same apiary stubbornly persist in carrying out their program of swarming; that some seasons practically all colonies go through the season without attempting to swarm, while in other seasons a majority of the colonies attempt to swarm; and that in some localities, as in some parts of the tropics, well-

managed colonies seldom swarm, while in other localities, especially in the far North, swarming is troublesome nearly every season. No wonder beekeepers have been searching for the thing that throws the switch which leads some colonies headlong into swarming, while others continue on the main track of gathering and storing honey.

Influence of Heredity

In the search for the thing that throws the switch, some have looked upon the tendency to swarm as an inherited trait that might be bred out; and at one time American beekeepers made a serious effort to eliminate swarming by careful selection of breeding-stock. Some even claimed actually to have accomplished this, but today it is generally agreed that a non-swarming strain of bees can not be developed by breeding. The swarming tendency has been greatly reduced, of course, by the elimination of stock too much given to swarming without sufficient excuse.

Influence of Size of Brood Chamber

Lack of sufficient room is generally recognized as contributing to the tendency to swarm. As a rule, colonies having large brood-chambers swarm less than colonies in small hives. Formerly much was said about colonies of bees established in attics never swarming, because such colonies had the whole attic for a hive. But swarms do issue from colonies housed in attics and other large cavities, and have been known to issue from colonies established under the eaves of buildings, having the whole out-of-doors for a hive. Swarms often issue from the largest of hives, even when tiered up five or six stories high. While under some conditions swarming is reduced by large brood-chambers, it can not be eliminated by increasing the size of brood chambers.

Influence of the Honey Flow

It has been said that bees swarm because of the honey flow, which makes them feel sufficiently prosperous to divide the colony and build a new home. In the North, swarming does usually come during the main honey flow; but in some localities, especially in the South, swarming occurs before the main honey flow, swarms sometimes issuing when the colonies are gathering scarcely enough for a living. In some places swarming ceases entirely on the arrival of the honey flow, while in other places swarming usually begins at the beginning of the main honey flow. While the honey flow often influences swarming, it can not be considered the real cause.

A light honey flow before the main flow will start swarming in Texas and in other parts of the South. When the main or heavy flow comes, all swarming will stop almost immediately and the bees will then be too busy taking care of the rush of nectar to think of swarming.

Influence of Drones

The presence of drones and drone brood has been considered as a cause of swarming. Working on this theory, Aspinwall constructed wooden combs by drilling holes into the ends of blocks of wood to form the cells in order to have all cells of worker size to prevent the rearing of drones. After years of research along this line he abandoned this theory of the cause of swarming and took up another theory to be mentioned later, which finally resulted in the invention of a non-swarming hive. In this hive, instead of eliminating the drones, he provided wide spaces between the combs, inserting in these spaces slatted dividers to prevent comb-building in the spaces.

Influence of the Age of the Queen

It is generally believed that colonies with young queens swarm less than those with old queens and there is not lacking evidence to prove it; but when conditions are right, especially some seasons, there may be an epidemic of swarming taking in colonies headed by young queens as well as old ones.

It is good practice to requeen every year, not only to reduce the tendency to swarm, but to insure enough egg laying so that there may be a large force of bees with which to produce a crop. Young queens like young pullets are generally more profitable than old ones, although there are sometimes marked exceptions.

Much of the trouble from swarming in colonies having old queens is from supersedure during the swarming season (see Queens, Supersedure of and Queen-rearing) when colonies often apparently depart from the original plan of supersedure and swarm because queen-cells are present. In many respects such swarming is quite different from normal swarming.

How Young Bees Contribute to Swarming

Gerstung, a German investigator, put forth the theory that swarming is brought on by a preponderance of young bees. This fits in well with the well-known fact that the swarming tendency is strongest early in the season when young bees are emerging in greatest numbers. It also explains why swarming is worse in those localities where the bees build up most rapidly in the spring and during those seasons when, because of favorable conditions, building up is most rapid, thus resulting in an unusual proportion of emerging and recently emerged young bees. This theory also explains why colonies are willing to give up swarming when their brood is taken away, as in artificial swarming.

Using this theory as a basis, comb-honey producers years ago worked out plans by which the brood and youngest bees were taken from the colony at swarming time, kept in a separate hive until old enough to do field work and then returned to the main colony. Producers of extracted honey, instead of putting the brood and young bees into a separate hive, placed the chamber containing the brood above the queen-excluder, the queen being confined below, thus separating the young and emerging bees from the colony below. In 1908 E. E. Coveyou advised placing the chamber of emerging bees above the supers to separate them still further from the colony. (See Gleanings in Bee Culture, 1908, pages 640-641.) This was further emphasized by A. C. Allen in 1910 (American Bee Journal, page 94) and Chalon Fowls in 1915 (Gleanings in Bee Culture, 1915, page 574.) Mr. Fowls especially emphasized the importance of having all the young bees in the old brood-chamber above the supers, having only bees old enough to work in the fields in the new brood-chamber below.

The Aspinwall non-swarming hive was based upon the young-bee theory as the cause of swarming. It provided extra room for these young bees between the combs. However, colonies made up largely of older bees have been known to swarm, and the young-bee theory does not explain why swarming is much more troublesome under certain weather conditions when the proportion of young bees is no greater than usual. While a large proportion of young bees, no doubt, contributes to bringing on swarming, they alone evidently are not always the cause.

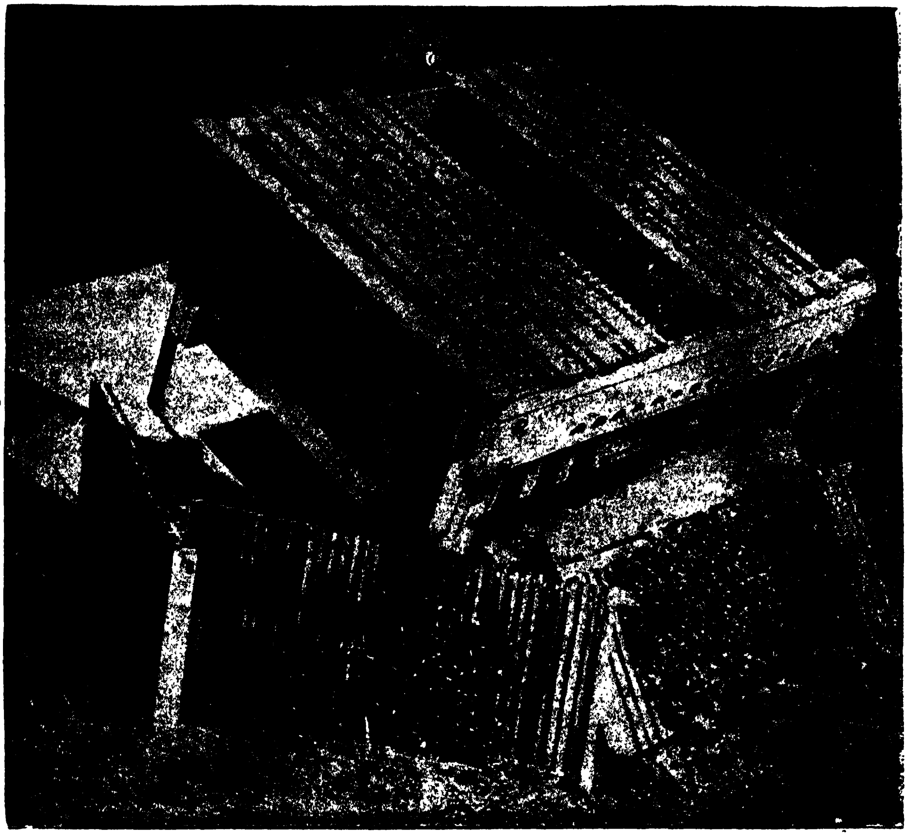
Aspinwall Non-Swarming Hive

This hive (next page) is shown not because it is in successful use nor because it is a commercial possibility, but because it sets forth one principle of swarm control mentioned, namely, a means for providing clustering space for bees in the brood nest that would otherwise congest it and thus bring on swarming. The combs are of Langstroth size. Between each of the brood combs is a slatted divider made up of a series of wooden slats bee-spaced apart. Why a bee-space? Because the bees will not fill these spaces with combs. On the ends of each of the frames are extra end-bars bee-spaced apart. This arrangement of a multiplicity of bee-spaces practically doubles the clustering space for young or old bees and thus relieves a congestion or a discomfort that would cause swarming. The hive is not practical, because the construction involving so many bee-spaced slats makes the hive so unwieldly and expensive that no one could afford to use it. There are other and simpler means at far less expense to relieve the congestion and that is to give extra supers as explained in the text.

The author used several of these hives with colonies of Carniolans (excessive swarmers) in the production of comb honey. Not one of them swarmed after being put in these hives and what is more, produced over 100 pounds of comb honey each.

How Field Bees Contribute to Swarming

The author has carefully gone over the back volumes of the bee journals for reports of seasons of excessive swarming, and in every case excessive swarming was attended by some factor which caused the field bees to stay in the hives during the heat of the day, such as rain or the flowers yielding only a part of the day. Swarming is much less troublesome in the irrigated regions of the West, where there is but little interference with field work on account of rain. In localities and seasons where nectar is available throughout the day there is less swarming than in localities and seasons where there is a dearth of nectar during a part of the day. During occasional seasons white clover has been known to yield only during the afternoons. When this



Aspinwall hive with slatted dividers, to provide room between the slats for the bees to cluster.

occurs the great horde of field workers crowd into the space below the frames and between the lower portion of the combs, apparently waiting near the entrance for the signal from scouts that the flowers have begun to yield. The congestion thus brought about, often when the weather is hot, usually brings on excessive swarming.

While a large proportion of bees too young for field work is apparently conducive to swarming, if to these is added the great horde of field bees all trying to stay within the already crowded brood-chamber, the congestion and discomfort are too much for even the best-bred bees. At such times bees often forget their manners and swarm most unreasonably.

One Factor Always Present in Swarming

Years of accumulated experience of beekeepers waging a bitter fight against swarming indicates that one thing is always present in normal swarming, so far as the prime swarm is concerned, whether the hive is large or small, whether the colony is weak or strong, whether the queen is two years old or two weeks old. This one thing that is always present is a congestion of bees within the brood-nest, bringing to the colony a feeling of strength or a need for expansion.

This, then, must be the cause of swarming. The many other things often mentioned as the cause, but which are not always present, are contributory to swarming only inasmuch as they may help to bring about the crowded condition within the brood-nest (not in the entire hive), which suggests to the colony its strength or need for expansion.

If this congestion is brought about in weak and medium colonies by the colony confining its work to the brood-chamber, leaving the supers and remote brood-combs vacant and crowding the queen by surrounding the brood-nest with

honey, the congestion within this little brood-nest is as real and as potent in bringing on the swarming impulse as though the colonies were twenty times as strong. The remedy is stronger colonies or a strain of bees less inclined to crowd the queen in this manner. If the congestion is brought about by field bees staying at home during the day because of discomfort brought about by a lack of ventilation or shade, the remedy is obvious. If the congestion is caused by a preponderance of young bees, the remedy is to invite these youngsters upstairs by giving a set of attractive empty combs immediately above the brood-combs, or if comb honey is being produced, a skilful management of the supers to attract the younger bees into the supers to the greatest possible degree. If the congestion is brought about by field bees staying at home, as they often do even when nectar is plentiful, because the hive is already crowded and uncomfortable, the remedy is to use an Aspinwall hive, or to invite more bees upstairs and give more ventilation if needed. How foolish for field bees to stay at home because the hive is not comfortable, when by doing so they only add to the discomfort! If the congestion in the brood-nest is caused by field bees staying at home during the heat of the day waiting for the flowers to begin to yield, the problem becomes more difficult; but here, again, anything that adds to the comfort of the colony should help.

Congestion of the brood-nest is a matter of distribution of the bees rather than numbers, for the hive can be expanded to accommodate all; but the bees must be induced to expand their work also as the hive is expanded. If most of the bees can be induced to leave the brood-nest, going either into the supers or to the fields, all is well.

PREVENTION OF SWARMING

Under this head will be considered the methods which reduce the tendency to swarm. After a colony has started to build queen-cells in preparation for swarming, especially after the queen-cells are well developed, the beekeeper may apply some measure to prevent the issuing of a swarm, such as removing the queen or making an artificial swarm.

The reader will understand from the discussion on preceding pages that swarm-preventive measures which work well in one locality may fail entirely in another; that measures which prevent swarming one season may fail to do so the next and that measures which will prevent swarming in one colony may fail to do so in another colony in the same apiary. The means that will discourage or stop swarming with Italians may fail with Carniolan bees. (See Races of Bees.) However, swarming can be greatly reduced for any locality during any season, and in some localities entirely prevented by careful attention to well-known preventive measures.

Following is a summary of some of the most important swarm-preventive measures. It will be noted that, with the exception of the first and the last items in the list, each of these is directly concerned with the prevention of congestion and discomfort within the brood-nest itself; or in other words, the removal of the cause of swarming as given above.

(1) Breeding to Reduce Swarming Tendencies

When things are allowed to take their own course in the apiary most of the increase is made during the swarming season, and the queens are reared from swarming-cells. The question has been raised whether such queens will not inherit more of the swarming tendency than those reared under the supersedure impulse. There can be no doubt that the indiscriminate use of queen-cells taken from swarming colonies will result in more and more swarming, since the queens would then be reared chiefly from colonies that are the worst offenders as to swarming.

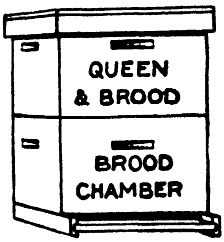
But the fact that the queen-cells are built in preparation for swarming instead of for supersedure probably does not change the tendency of the resulting queen toward swarming. So far as is known, there is no objection to the use of swarming-cells from colonies that are otherwise desirable, but that have been forced to swarm through neglect or bad management. Neither is there any objection to having queen-cells built by swarming colonies, the larvae for which have been transferred from the colony having the breeding queen. Since swarming-cells are built at the time the colony is quite prosperous, such cells usually result in fine, vigorous young queens.

The strain of bees can be greatly improved by killing the queens of any colonies which prepare to swarm when there is no excuse for swarming, and replacing them with queens reared from colonies which show no tendency to swarm under the same conditions.

(2) Large Brood-chambers to Prevent Swarming

In the colder climates, brood-rearing is usually carried on with a rush during the spring, and for a short time at least the colonies will have a larger amount of brood than in warmer climates. During this short intensive brood-rearing period it is important that the queen shall have more room than she can occupy with brood, and thus scatter the brood somewhat. If the brood-chamber is too small for this, the colony will become crowded and probably swarm. For this reason some beekeepers prefer to use brood-chambers larger than the standard ten-frame hive of Langstroth dimensions. Some use the Jumbo hive, especially for extracted-honey production; while others prefer a hive even larger than the ten-frame Jumbo, some advocating using Jumbo frames in hives holding eleven, twelve or thirteen frames. However, in some localities where honey flows are slow, as in portions of the South, very large brood-chambers often result in poor work in the supers.

Those who use the regular standard Langstroth size hive will for the most part use the food chamber winter and spring. As the bees eat out the stores in the food chamber this automatically provides increasing room for the queen upstairs. The upper story and the lower story combined makes a larger hive than

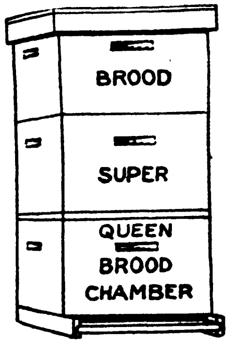


Previous to the honey flow the queen occupies both stories.

any that have been used or are on the market, and many times with a good queen there will be from sixteen to eighteen frames of brood at one time. (See Spring Management and Food Chamber.) The advantage of this double chamber is that there is increasing room as the season progresses and always room for the best queens. In addition to this the equipment of hives is standard.

When the colony reaches its peak the queen, by the use of the queen-excluder, can be confined to the lower story. (See Demaree Plan of Swarm Control.)

Many comb-honey producers use the same plan, leaving on the food chamber until the beginning of the honey flow when the brood nest is reduced to a single



Queen is put below excluder and brood placed above the super.

story and the comb-honey supers put on. The extra hive-bodies that are removed are then either tiered up on certain colonies set aside for this purpose, or are used in making increase. If no increase is desired, the extra hive-body, together with the extra combs of brood and honey and enough bees to take care of them, can be used to make a good-sized nucleus, which should be supplied with a ripe queen-cell and the hive placed close beside the original hive. At the close of the season the two colonies can be united by the newspaper plan (see Uniting Bees). In the majority of cases the young queen will be retained when no attention is paid to the queens, but to insure this the old queen may be killed. (See Requeening Without Dequeening.)

While this plan can not be depended upon everywhere to prevent all swarming, if properly put into effect it should be as effective as or more so than a larger brood-chamber on account of the added stimulus to brood-rearing resulting from the establishment of a new brood-

nest above, then later below the excluder in a set of combs being rapidly vacated by emerging young bees.

(3) Importance of Perfect Worker Comb

Not only does a large amount of drone comb in the brood-chamber result in the rearing of a great number of drones, which can only be in the way, and help bring about a crowded condition within the brood-chamber, but also every cell of drone comb or every distorted cell that can not be used for rearing workers really reduces the size of the brood-chamber so far as profitable brood-rearing is concerned.

(4) Barriers in the Way of the Queen

There should be no barriers in the way of the free expansion of the brood-nest in the spring. If combs which are unsuitable for brood-rearing are between good combs, the poor combs stand in the way as a barrier. Sometimes rather than to cross such a barrier the queen will confine herself to one side of the hive and the colony will become crowded even with an abundance of empty comb beyond. This is more liable to happen with weak colonies than with strong ones; but, even with strong colonies, there should be nothing in the way of the free expansion of the brood-nest in the spring. Inserting a new comb in which no brood has ever been reared in the middle of the brood-chamber sometimes stands in the way and causes the queen to work only on one side of it for some time before she begins to lay in it. Inserting a frame of foundation is, of course, a greater barrier, but in each case this is only a temporary barrier and in the case of very strong colonies often none at all. If two stories are used for brood-rearing it is important that the combs in the lower story at least have worker-cells to the top-bars, so that the queen will pass readily from one story to another. (See Three-ply Comb Foundation under Comb Foundation.)

(5) Providing Abundant Ventilation

If the entrance is too small it is extremely difficult for the bees to ventilate the hive properly. At the beginning of the honey harvest all colonies should have their entrance-closers removed; and if any of the colonies still seem inclined to cluster out and loaf, more ventilation may be given by placing four blocks between the hive and the bottom-board. This will provide an opening on all four sides. While the bees will use the front entrance mainly, they will also fly from the others. With so much ventilation the bees, unless the colonies are extraordinarily strong, will go back into the hive and go to work. By giving plenty of bottom ventilation it will take fewer bees to keep the hive cool than with a restricted entrance.

In this connection it may be well to explain that one set of bees will place themselves in such a position that they force a current of air into the hive, and another set forces the warm moist air out of it. After the bees have been heavily at work in the field, if one will light a match and hold it in front of the entrance, he will find there is a strong current of air going in on one side and another strong current going out at the other side. Sometimes the air seems to go in at both sides and come out in the center. (See Ventilation and Entrances.)

During extremely hot weather many extracted-honey producers provide additional ventilation by "staggering" the stories—that is, the second story is shoved forward enough to leave a ventilating space of half an inch at the back, between the two stories. If necessary, the third is shoved back to leave a similar space at the front between the second and third. The fourth is shoved forward, etc.; and last of all, the cover is shoved forward to leave another half-inch space. When producing comb honey it is necessary to keep the supers warm enough so that comb-building may continue at night. Therefore stories should not be "staggered" in comb honey production.

When the hives are not blocked up to allow additional ventilation a large space between the bottom-bars of the frames and the floor of the hive is advantageous in hot weather. In hives as ordinarily made in this country this space is ⅞ of an inch, which is about as much as can be given without bees building combs below the bottoms-bars of the frames, especially in comb-honey production. A space two inches deep or more would be better still, so far as swarming is concerned, if the bees would not build comb in this space. Such a space can be used, however, by putting a slatted rack (slats a bee-space apart) under the frames to prevent building comb below. This affords a large amount of room for the field bees during the night as well as during

the day if the flowers yield only a part of the day, or the field force is held in by rain. It also provides an abundance of ventilation.

(6) Giving Shade

Practically the same reasons that apply for giving an abundance of ventilation also apply here. A colony in a hive that is exposed to the direct rays of the sun has a much more difficult problem in keeping the interior of the hive cool than when the hive is in the shade. Under the head of Apiary, various means for shading the hive are illustrated and described. If a hive is exposed to the hot sun it requires a good many bees to keep up the ventilation, and these bees might otherwise be in the field at work.

Painting the hive white adds to the comfort of the bees, because the light color reflects the rays of the sun and prevents the hive from being heated as much as it would if it were a darker color.

(7) Barrier of Sealed Honey Around the Brood-nest

Colonies that are weak or only medium in strength at the beginning of the honey flow are inclined to store the honey in the brood-chamber adjacent to the brood, thus surrounding the brood-nest with honey. When the brood-nest is crowded in this way the bees are not inclined to pass over the finished sealed honey readily to go into the supers when given. Such colonies, therefore, block off and occupy only a portion of their hive, and crowd this limited portion even though empty combs are given in the supers above. On the other hand, the strong colonies readily expand beyond such barriers. For this reason it is often more difficult to prevent swarming in colonies of medium strength than in strong ones. Barriers of this kind between the brood-nest and the supers are especially objectionable in colonies of medium strength. This part of swarm prevention, therefore, reaches back to the spring, the winter, and the preceding fall and late summer management.

(8) Importance of Strong Colonies

Strange as it may seem, it is usually easier to prevent swarming in strong colonies than in weak or medium colonies. Strong colonies expand readily into the supers when they are needed and push their work beyond barriers that would ordinarily stand in the way of expansion of weak colonies. In this way the bees of a strong colony distribute themselves throughout the hive and supers, thus relieving the brood-nest from congestion. Not only for swarm-prevention is it desirable to have the colonies uniformly strong in the spring, but, as is well known, this is one of the first requirements in producing a large crop of honey. Fortunately, therefore, this phase of swarm prevention is simply good beekeeping. (See Food Chamber and Spring Management.)

(9) Early Work in Supers

Since the tendency to swarm is stronger during the early part of the honey flow, if the colonies are strong in young bees at that time, it is important that each colony expand into and occupy promptly the first super that is given. To accomplish this it is necessary that the first super be attractive to the young hive-workers. If supers, either for comb honey or for extracted honey, having only foundation be given to a strong colony just before the honey flow, the bees will not take possession of them and begin work on the foundation to any extent until the honey flow has actually begun. In the meantime the colony may become crowded for room. The addition of this super, therefore, does not affect the distribution of the bees until they take possession of and occupy the super, while in the meantime conditions for swarming may develop rapidly. On the other hand, if a super of empty combs is given to a strong colony some time previous to the honey flow, the younger bees in great numbers immediately take possession of the super and begin to repair the comb and to prepare it for use.

The first super for extracted honey production should be supplied with empty combs if these are available. If not enough empty combs are at hand for this, at least half of the frames in each super should contain empty combs. If no empty combs are available, some of the combs of brood should be taken from the brood-chamber and put into the super to induce the bees to move up promptly.

The first comb-honey supers are usually put on later than supers for extracted honey. They should contain some sections with combs already built, which were saved from the previous year. These combs will often induce the bees to occupy the super earlier than would be the

case if only foundation is used in the sections.

During the early part of the honey flow, when swarming is imminent, additional supers should be added as the bees need them before any of the workers are crowded back into the brood-chamber. If the honey flow is good, the additional supers should be given as fast as the bees can be induced to occupy them, in order that the expansion of the work and the room in the supers shall keep pace with the oncoming of the young workers. Each newly added super should be so accessible, comfortable, and attractive that young bees will come up and occupy it at once, which they may fail to do if the newly added supers are too hot, too cold, too remote, difficult to ventilate, or otherwise unattractive. During the latter part of the honey flow, as the swarming season begins to wane, bees may be crowded to induce them to finish the work well and concentrate the honey in fewer supers, but by this time there is less danger of swarming. (See Comb Honey, to Produce, subhead Tiering up, and the Demaree Plan of Swarm Control.)

(10) Room in Combs for Ripening Nectar

It should also be remembered that the thin incoming nectar requires more room in the combs than it does after it has been ripened. Besides this the bees do not fill the cells full of thin nectar, but place only a small amount in each cell in order that it may be more promptly ripened. For this reason it is necessary to provide more super room than would be needed otherwise. When adding supers it is well to keep in mind this extra need for room for ripening nectar as well as for the storage of ripened honey.

(11) Removing One or Two Combs of Brood

When producing extracted honey it is sometimes advisable to take out one of two combs of brood from the brood-chamber and place them in the super, putting in their place empty combs in order to give the queen more room if she becomes crowded. In addition to giving the queen more room, there is no doubt some advantage in having these young bees emerge in a super, possibly at the top of the hive, remote from the brood-chamber, in order to bring about a better distribution of the young bees throughout the hive. This plan is not well adapted to comb-honey production, although some who produce comb honey remove one or two frames of brood from colonies that are crowded, giving these combs to nuclei or weak colonies.

Removing the Queen to Prevent Swarming

Some have advocated removing or caging the queen to prevent swarming. The plan will work provided all cells are cut out so that there shall be no virgin to lead out the swarm. The objection to the plan is that the colony without a queen does not work with the same vigor as one that has a queen. The plan while once common, has all but gone out of use. The author recommends the other methods or a combination of all of them first, viz.: plenty of room, ventilation, shade, and a young queen.

(12) Destroying Queen-cells

In some cases destroying queen-cells is really a remedial measure; but, if destroyed when first started and more super room or more ventilation is given at the same time, it may be proper to consider destroying queen-cells as a preventive measure. There are some very nice points in cell-killing. As Dr. Miller had the largest experience of any man in the United States, if not in the world, the author asked him to give his views; and the reader will do well to go over very carefully what he said:

I have yours asking some questions about cutting out cells to combat swarming, and proceed to reply. We don't call it cutting cells here, but "killing cells," the term "cutting cells" being applied to cutting out ripe queen-cells that are to be used for rearing queens. When we find queen-cells constructed as a preparation for swarming, we never cut them out. If a cell contains a larva several days old, it is simply mashed with the end of the hive-tool. If an egg or a small larva is in the cell, it may be mashed or the egg or larva may be dug out. In either case the work is very quickly done, and a very slight defacement will cause the bees to reject the cell.

We begin looking for swarming cells just as soon as we think there is any danger of their being started, or a little before. The first time we look in a few of the strongest colonies—perhaps the first of June, before the bees begin to store from white clover—and if we find no cells started in these we go no further, for if the strongest have not thought of swarming the weaker ones may be trusted for a time longer. After that we try again in eight or ten days. Ten days may be as well as a shorter time. Indeed, as the young queen will be started from the egg there is no danger that she will go off with a swarm under fifteen days. But if we go beyond ten days, complications may arise by means of swarming with the old queen, and, as there is some danger of delays from rainy weather or other cause, it is not a bad plan to make eight days the period. Then if it is delayed a day or two for any cause, we are still all right.

The second time we look again in the strongest colonies, and if no cells are found in these we go no further. But whenever we find one or more cells started in any one of these

strongest colonies, then every colony must be examined. At least that will be the way early in the season; later on there will be exceptions.

Some one may ask at what stage of the growth of queen-cells they are destroyed. At any or all stages. In fact, no thought is given to whether advanced cells or only eggs are to be found. Every eight or ten days we go through each colony and kill all cells found.

At the first overhauling and at any subsequent one so long as no cells have been found at a previous overhauling, the bees are shaken from each comb. One sharp shake will usually leave the comb clean enough. This allows the cells to be more easily seen, whereas if all the bees are left on, some cells may escape detection. If no cell is found, then the page of the colony is found in the record book, and the entry "no c." is made after the date. Some years we have omitted such entry so long as no cells have been found in the colony that season, leaving it to be understood that so long as no entry as to cells appears, no cell has been found. But it is a little safer to make the entry, for then we can be sure that we have not killed cells and forgotten to make the entry.

The beginner is very likely to think that all that is necessary to prevent swarming is to continue regularly killing cells, believing that there will be no swarming so long as no cells are allowed to approach the sealing stage. But it doesn't work out that way. After a colony once fully gets into the notion of swarming, it seems only to make it more stubborn to have its cells killed, and finally it may swarm with nothing further than eggs in queen-cells, if indeed there is that much preparation.

So it is a matter of some nicety to decide when it is wise to continue to depend upon killing cells and when to resort to some other measures. Suppose a colony had cells killed June 10, and it is again visited June 18, 19, or 20, and at this time nothing further than eggs are found in queen-cells. No trouble to decide in this case. Kill the eggs, and continue killing them each time no further advance is made. It sometimes happens that eggs are found upon one or two visits, and then the bees go through the rest of the season without any further thought of swarming.

How to Distinguish Supersedure Cells from Swarming Cells

When bees are preparing to supersede their queen they usually build only a few queen-cells instead of building many as they do when preparing to swarm. Sometimes only one or two queen-cells are started, then later the bees may start other cells, so that there may be queen-cells in all stages of development from one containing only an egg to one or more from which the young queen is almost ready to emerge. On the other hand, when preparing to swarm the bees usually start a number of queen-cells, sometimes as many as a dozen or more at about the same time, so that they are all in about the same stage of development.

It is also possible to tell supersedure cells from swarming cells by the condition of the colony. In the case of supersedure cells there are usually indications of the queen's beginning to fail, such as a somewhat scattered condition of the brood, while in the case of swarming there is usually an unusual amount of brood in the hive. It must be remembered, however, that colonies may start queen-cells under the supersedure impulse, and, if during the swarming season, the presence of these cells apparently causes them to switch over to the swarming impulse.

SWEET CLOVER *(Melilotus.* Greek word from meli, honey, and lotus, a leguminous plant.)—There are about 20 species of sweet clover, natives of Asia, Africa and Europe. Nine species are found in France. Four have been introduced into North America. The sweet clovers were known to the ancient Greeks more than 2000 years ago, and in the Mediterranean region were valued as honey plants, as well as for forage and green manure. They are now distributed over the entire civilized world, usually growing on waste land; but in Australia, South Africa, and the United States they have been cultivated with remarkable success. Many species of sweet clover have been more or less utilized in the old world, but those most commonly cultivated in the United States are: The white biennial sweet clover *(Melilotus alba)*, white annual sweet clover *(Melilotus alba var. annual)*, the large yellow annual biennial *(M. officinalis)*, and the small yellow annual *(M. indica)*. The white annual sweet variety, commonly known as Hubam, will be described farther on under a separate head.

Sweet clover once classed as a noxious weed and legislated against by state and municipal laws, is now accepted as one of the greatest blessings to mankind. It is by far the most important honey plant in the United States. It excels in quantity yields white clover, its nearest competitor, by almost ten to one. From the standpoint of flavor it would rank second to white clover in the East; but in the West, where its production is the greatest, it would be preferred to white clover and stand on a par with alfalfa and orange. In flavor it has a suggestion of vanilla, more pronounced than alfalfa and milder than orange. Its quality, body and color is such that it blends well with almost any other light table honey such as white clover and basswood of the East, alfalfa of the Rockies, orange of California and Florida, tupelo, palmetto, and gallberry of the South. It is the one

honey that the big packers of bottled honey can always depend on for their supply. During seasons of drouth sweet clover and to a less extent alfalfa can always be had in car lots. In fact, sweet clover honey forms from fifty to seventy-five per cent of the blend of honey sold at retail in glass or tin. In the East there would be a larger proportion of white clover in the blend to satisfy the taste of those who prize white clover. In the West there might be no white clover but a blend of alfalfa and orange to meet the demand for a flavor which consumers beyond the Mississippi prefer. It is rather significant that in both the West and the East sweet clover forms the larger percentage of the blend in table honeys.

No crop is more sensitive to a lack of lime in the soil than sweet clover, but it will grow in soils so strongly alkaline that alfalfa will die out. It will stand more dry weather or drouth than any legume or hay plant known to the farmers. Had it not been for sweet clover during the drouth from 1928 to 1934 in the eastern states, table honey would have been a scarce article and the farmer would

White sweet clover (Melilotus alba.)

have been in a serious plight for the want of pasture land. Sweet clover during those years of drouth, and there may be more of them, came magnificently to the rescue of both the beekeeper and the farmer; but the drouth in Kansas, Nebraska and the Dakotas was so severe in 1934 that even sweet clover was killed.

The lessons of the drouth throughout the eastern states from 1928 to 1935 taught the farmer to put in sweet clover as he had never done before. Provided there is lime enough in the soil, it will make a catch where alfalfa would fail to grow. The county agents are now preaching sweet clover to the farmers as they never did before, so that now single counties will have from two to three thousand acres of the legume where two years ago there was hardly a single acre of it. Some states now have from one hundred thousand to over a million acres of it, much of which is grown for pasturage for dairy farms and cattle and bees thrive on sweet clover pasturage. It does not cause bloat like alfalfa, which is harder to grow and moreover, the constant cropping keeps the pasturage green from spring till fall and that, too, during a season so dry that timothy, alsike or red clover would be killed out.

The United States census figures for 1930, while much below those for 1934, at the time this is written, will give the distribution and acreage that prevailed in 1930. It should be remembered that the present distribution and acreage from good estimates are much greater than the 1930 census figures.

Alabama, 4,006; Arizona, 673; Arkansas, 3,823; California, 16,679; Colorado, 29,952; Connecticut, 809; Florida, 138; Idaho, 7,124; Illinois, 135,310; Indiana, 51,250; Iowa, 159,915; Kansas, 153,910; Kentucky, 13,601; Louisiana, 992; Maine, 56; Maryland, 3,653; Massachusetts, 605; Michigan, 59,694; Minnesota, 147,903; Mississippi, 5,099; Missouri, 61,145; Montana, 30,583; Nebraska, 192,116; Nevada, 746; New Hampshire, 325; New Jersey, 1,925; New Mexico, 1,510; New York, 23,444; North Carolina, 5,010; North Dakota, 238,917; Ohio, 76,482; Oklahoma, 69,052; Oregon, 3,562; Pennsylvania, 13,181; Rhode Island, 95; South Carolina, 1,193; South Dakota, 133,384; Tennessee, 7,938; Texas, 10,914; Utah, 2,559; Vermont, 708; Virginia, 6,484; Washington, 5,362; West Virginia 1,360; Wisconsin, 68,699; Wyoming, 6,451.

It will be noted in what follows that the Department of Farm Crops for Ohio credits Ohio for 1930 with 300,000 acres of sweet clover while the United States census figures gives her only 76,482 acres. If these same ratios held true for the other states we would have to multiply the census figures by three or four. It is evident that at the present time (1935) the acreage has gone much beyond Uncle Sam's figures for 1930.

The other virtues of sweet clover, from an agricultural standpoint, how it improves the soil, the requirements necessary to make it grow, its value as a hay crop when cut early are well set forth in a bulletin on sweet clover by Prof. C. J. Willard (Extension Bulletin No. 55 from the Ohio State University). It is written in plain language so that any farmer or beekeeper can understand it. Of all the bulletins on the subject that the author has read, we consider this the best. It is so good that we are quoting it entire.

SWEET CLOVER FOR OHIO

A crop revolution has occurred in Ohio and other states of the corn belt. Fifteen years ago one would have traveled far to find a total of 1000 acres of sweet clover sown as a crop in Ohio. Today a single county has 30,000 acres of sweet clover, and the entire state over 300,000 acres. It is already the second legume in the state in acreage, being exceeded only by red clover. Sweet clover has become one of the standard farm crops of the state, furnishing rich hay and pasture and making possible the production of larger and larger yields of grain.

KINDS OF SWEET CLOVER

There are four kinds of sweet clover of which seed is obtainable in the seed trade. They are the biennial white, the biennial yellow, the annual white or Hubam, and the annual yellow. The annual yellow has no place in Ohio. When sown in the spring it makes a growth of from 10 to 15 inches, forms seed, and dies by midsummer. The seed is very inexpensive, and has been sold as a substitute for other sweet clovers, though the seeds are easily distinguished.

Hubam Clover.—Much has been heard in recent years concerning annual white sweet clover, or Hubam clover. This has two qualities to recommend it: (1) it may produce more hay in the summer and fall after small grain than any other crop that can be sown in small grain. (2) If Hubam is plowed under in the fall of the year it is sown, it does not sprout from the roots and so becomes a weed the next year. However, the hay is inferior in quality to that produced by the biennial sweet clovers the same year they are seeded, and its root system is so small that its soil-improving value is very slight unless the entire crop is plowed under. Even then it is much inferior to the biennial sweet clovers. All things considered, there is little to suggest an extensive use of Hubam in Ohio, though it is a valuable crop in some circumstances .(See Sweet Clover, White Annual, or Hubam, further on.)

White or Yellow Biennial?—Of the two biennials, the white is more widely grown, and is the best for general Ohio conditions. When

sown in the spring, the white will make decidedly more hay the first fall than the yellow, but the yellow produces a greater proportion of roots, so the total organic matter produced may not be greatly different. The second year, the yellow has much finer stems than the white, matures from 10 days to two weeks earlier and yields less. The white may have a somewhat deeper root system than the yellow. For hay the first year, or pasture the second, sow the white; for hay the second year the yellow may be better because of its finer stems.

For soil improvement, the two are of practically equal value. The yellow seems to be surer to make a stand in dry weather than the white is and may, therefore, be preferable in sowing in corn or for summer seedings for soil improvement. Likewise, the seed crop of the yellow is easier to harvest.

There are a number of strains of biennial white, some of which differ as widely as do red and mammoth clovers. A strain which has assumed considerable commercial importance is the Grundy County sweet clover, a very early maturing strain which originated in Grundy County, Illinois. This strain is like the yellow in being less desirable for hay the first year or pasture the second. For soil improvement it seems to be nearly equal to the larger strains. It is much superior to the ordinary white in seed habits, and in the last year or two considerable Grundy County seed has been sold instead of the ordinary large white. This has meant a distinct loss to the purchaser if he wanted it for pasture, or for hay the first year.

Much more experimentation by farmers and experiment stations is needed before the better strains of the biennial sweet clovers are developed and made known, but meanwhile one can not go wrong in using any one of them. Since the ordinary strain of biennial white sweet clover is responsible for most of the remarkable interest in the crop, it is the only one which will be considered hereafter, though the discussion applies to any of the biennial sorts.

WHY SWEET CLOVER IS VALUABLE

Sweet Clover Grows Anywhere—If Lime is Present.—Sweet clover may be found growing along roadsides, in beach sand, on railroad embankments, along streams, and in washed and gullied fields. This wide distribution in waste places gave the plant its former reputation as a weed. When one attempts to domesticate it, however, he finds one important limitation—the soil must be sweet. While sweet clover will grow sometimes in slightly acid soils, in practice a neutral or basic soil is required for a profitable crop. Even alfalfa is not more particular in this respect. Given this, however, it is tolerant of most other soil conditions. Sweet clover will grow on poorly drained soils nearly as well as alsike, although it may winterkill by heaving on such soils. On the other hand, sweet clover is extremly drouth resistant, more so than alfalfa, and as a consequence it furnishes pasturage during summer dry periods when other pasture plants fail.

Sweet Clover Makes Enormous Yields.—Under favorable conditions alfalfa is its only competitor. Not only does it usually make more top growth than red or alsike clover, but it makes more root growth than any other biennial legume. In April, 1923, for example, plots of sweet clover yielded more than twice as many pounds of roots per acre as adjacent red clover plots. This root system is remarkably deep, and on some soil types the roots are of large size to considerable depth. In July of the second year, roots were found to a depth of 5½ feet in ordinary upland soil on the Ohio State University farm. Even in the fall of the year the sweet clover is seeded, the roots may be 4 feet deep.

Other Valuable Features.—Sweet clover is resistant to many diseases. Root rot, anthracnose, and similar diseases which have reduced the yield and acreage of red clover in recent years do not affect it. However, since sweet clover has become widely grown, a little-known disease has sometimes destroyed the second years' growth in May, making it less valuable for pasture purposes. Sweet clover has the same nitrogen fixing bacteria alfalfa, and so prepares the way for alfalfa by thoroughly inoculating the soil and by improving the drainage as well.

SWEET CLOVER FOR SOIL IMPROVEMENT

The Equal of 20 Tons of Farm Manure.—The most important single use for sweet clover is as a soil-improving crop. Many farmers grow it for this purpose only, and all who grow it

The heavy growth of sweet clover furnishes an enormous amount of hay per acre. Farms in Pendleton County, Kentucky, that were thought to be "worn out" years ago, suddenly became highly productive through the agency of sweet clover.

have in mind its value for this purpose. On soils containing lime or to which lime can be added, sweet clover is so much the best soil builder that it stands alone.

Sweet clover sown in wheat or oats in the spring and plowed under for corn in late April or early May a year later will turn to the soil anywhere from 75 to as much as 250 pounds of nitrogen per acre. It will require 20 tons of ordinary farm manure to add 200 pounds of nitrogen to the soil. How many farmers apply 20 tons of manure to each acre every 4 years? The equivalent of this can easily be secured and a grain crop produced every year by sowing sweet clover in the small grain and plowing it under for corn in the 4-year rotation of corn-oats-corn-wheat.

Feeding Sweet Clover to Crops.—One hundred and fifty pounds of nitrogen are sufficient for the grain and stover of 100 bushels of corn. As an average of 6 years' experiments we have found over 100 pounds of nitrogen in sweet clover on upland at the Ohio State University on May 1. It is no accident that many of our 100-bushel corn club records have been made after sweet clover has been plowed under. Sweet clover has also been used by many farmers who have entered the 400-bushel potato project. Observations in both Pennsylvania and Ohio indicate that it is a very satisfactory soil-improving crop to precede potatoes. The nitrogen in sweet clover plowed under in this way is available as rapidly as the succeeding crop can use it, since green, succulent sweet clover decomposes in from 21 to 28 days.

Sweet clover also has unusual power to make use of the less available plant foods of the soil, especially phosphorus compounds. These materials are gathered from the deep layers of the soil by the sweet clover roots, and then become available to the next crop when the clover is plowed down.

Renews Tilth and Drainage.—The soil is also greatly improved physically. The land plows more easily after a crop of sweet clover has decayed because of the loosening effect of the organic matter returned. The drainage of some soil types is tremendously improved. As these large roots decay, open channels for water are left through the hard subsoil, while the structure of the subsoil is improved by the residues added to it. Many farmers have found after growing sweet clover that drain tile which had gradually failed to carry off all the water between the tile because of the increasing compactness of the soil under continued cultivation, now keep all the land free of water.

Rotations for Soil Building.—The most popular and practical way to use sweet clover as a soil builder is as a catch crop in a 2-year rotation of corn-oats or corn-wheat, in which sweet clover is sown in the small grain and plowed down the following spring for corn. This combination can be worked into many practical rotations to serve different purposes. The following 4-year rotations will illustrate:

(a) Corn, oats (sweet clover), corn, wheat (sweet clover).

(b) Corn, oats, red clover, wheat (sweet clover).

(c) Corn, corn, soybeans, wheat (sweet clover).

(d) Corn, oats (sweet clover), potatoes, wheat (sweet clover).

Many modifications and combinations of these rotations can be worked out. Canning crops particularly have benefited by the sweet clover catch crop.

Plow Under in Spring After Growth is Well Started.—In these rotations the sweet clover can be plowed down in the spring after it has made from 8 to 15 inches of new growth. Plowing at this time entirely kills sweet clover. On the other hand, if biennial sweet clover is plowed the fall after seeding or very early in the spring, the big fleshy roots are not killed, and stalks come up in the succeeding crop almost as if the land had not been plowed. This is the only way in which sweet clover is ever a weed in cultivated land, but nearly every farmer who has raised sweet clover has learned by experience how troublesome it can be in this way. However, many farmers plow sweet clover in the fall or early spring, and trust to repeated discings to kill the sprouts which appear.

There is little advantage in waiting for more growth after the sweet clover is large enough so that it will be killed. A considerable part of the top growth is offset by a loss in the amount of roots, while if plowing is delayed too long a dry spell may make it hard to prepare a seedbed for the crop following. In a wet season, sweet clover may be plowed sooner than bare ground because of this drying effect. The roots of sweet clover make it harder to

As high as 100,000 pounds of sweet clover seed was shipped each season from this warehouse at Falmouth, Kentucky. A sweet clover fed horse. Note the sleekness of his coat.

plow at this time than bare land, but it is by no means as hard to plow as alfalfa.

Two-year versus Three-year Rotations for Sweet Clover.—Some prefer to let sweet clover stand the entire second year even if grown only for soil improvment. The plant makes an enormous top growth, so that one feels that he must be adding much more fertility to the soil by letting it stand the entire year than by plowing under May 1. So far as nitrogen content is concerned, this is not true. As an average of four years, in well grown sweet clover, we have found four-fifths of the maximum amount of nitrogen to be present on May 1. The better the growth in the first season, the earlier the maximum nitrogen is reached. When left the entire second year, much nitrogen must be lost by leaching before the corn crop of the succeeding year can use it.

Furthermore, the value of a green manure is somewhat in proportion to the percentage of nitrogen it contains. Sweet clover on May 1 contains 3 to 4 per cent of nitrogen, while in July it contains only 1.5 to 2 per cent.

However, on some soil types a decidedly larger yield of corn has resulted from leaving sweet clover for the full second year, that is, in a three-year rotation of corn, oats, sweet clover, instead of the two-year rotation corn, oats, with a sweet clover catch crop. This seems to be especially true on the poorer soils and on soils where the effect of sweet clover on the physical condition is especially important, but it is not yet clear just where, if anywhere, it pays to let the crop stand the full year.

Fig. 2.—Sweet clover pasture in North Dakota. "I will bring you . . . . unto a land flowing with milk and honey."—Exodus 3:17.

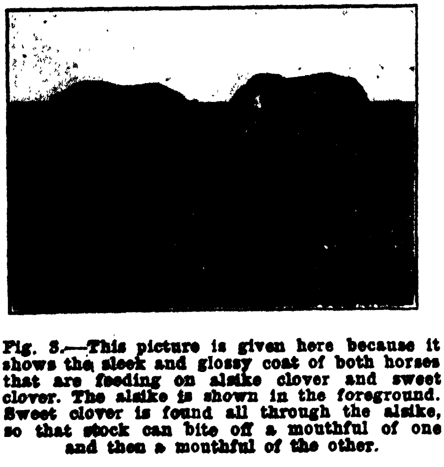


Fig. 3.—This picture is given here because it shows the sleek and glossy coat of both horses that are feeding on alsike clover and sweet clover. The alsike is shown in the foreground. Sweet clover is found all through the alsike, so that stock can bite off a mouthful of one and then a mouthful of the other.

SWEET CLOVER FOR PASTURE

Sweet clover is rapidly becoming one of the leading pasture plants of the corn belt. The old belief that "stock won't eat it" has been exploded too often to have weight at this time. When stock that are not used to it are turned into a pasture containing sweet clover and plenty of other feed they do not eat the sweet clover, but if turned into sweet clover alone when in proper condition or into a mixed pasture early, little trouble will be experienced.

Many Virtues as Pasture.—Its carrying capacity is amazing. The difficulty is usually to keep stock enough on it to keep it from getting too coarse. Farmers have estimated the carrying capacity of sweet clover to be from one to four mature animals per acre. In general, it will carry double the stock that bluegrass or mixed grass pasture will on the same land. Stock of all kinds thrive on it.

Sweet clover is very high in minerals, especially calcium, and so is particularly valuable for dairy cattle and young stock. It never fails to cause an increased milk flow. Opinions differ as to its effect on the flavor of the milk, but many dairymen use it with no complaints. It can be pastured from one to two weeks sooner than other pastures. Bloating is less common on sweet clover pasture. There have been a few cases in wet weather, but there is very much less danger than in pasturing any other legume.

Sweet clover may be used as hog pasture. The first year's growth, especially, is nearly or quite the equal of alfalfa. The second year's

growth becomes coarse too rapidly for best results as hog pasture.

Sweet Clover Well Grazed is Best.—Some care is needed to get the greatest use out of the pasture. Stock should be turned on sweet clover early and the pasture should be stocked so that it does not get ahead of the stock, yet not so heavily as to kill it. If it is not kept eaten it will get coarse, bloom, form seed and die in early August, while by keeping it pastured off it may be made to furnish succulent pasture for a much longer period.

Sweet Clover in Permanent Pastures.—Sweet clover can not maintain itself in a good bluegrass sod, and the young plants can not stand the grazing they receive in a permanent pasture. It is valuable in the seeding mixture on adapted soils when starting or improving a permanent pasture, but it will disappear as rapidly as red clover under pasturing. It has a distinct value in the improvement of run-out permanent pastures, especially on the shaly hillsides of eastern Ohio.

Sweet Clover in Rotation Pastures.—The way to secure the most pasture from sweet clover is to pasture it in a regular rotation, for example: Corn, oats, wheat, sweet clover. The second year's growth is pastured from early spring until it dies out in August or early September. By that time the sweet clover in the wheat stubble is ready to furnish pasture for the rest of the season, thus furnishing an all-season supply of feed. A still better rotation is corn, oats (sweet clover), corn, wheat, sweet clover. This five-year rotation will give two fields of sweet clover to pasture each fall, which will more nearly balance the carrying capacity of the second year crop.

SWEET CLOVER HAY

First Year Hay the Equal of Alfalfa.—Hay may be cut from sweet clover either the year after it is sown, as with red and alsike clover, or, on well-adapted soils, in the fall of the year it is sown. The best hay from sweet clover is secured the year it is sown. The hay is fine, leafy, easily cured, and the equal of any alfalfa in composition, palatability and feeding value. It should ordinarily be cut late in September, and need not be cut higher than other hay crops are cut. On good soils, the yields will average from 1 to 2 tons, with exceptional yields higher. The 2-year rotations—corn, oats (sweet clover), or corn, wheat (sweet clover) are thus among the most extensive possible, since they give two grain crops, a hay crop and a green manure crop large enough to maintain and increase the grain yields, all in two years.

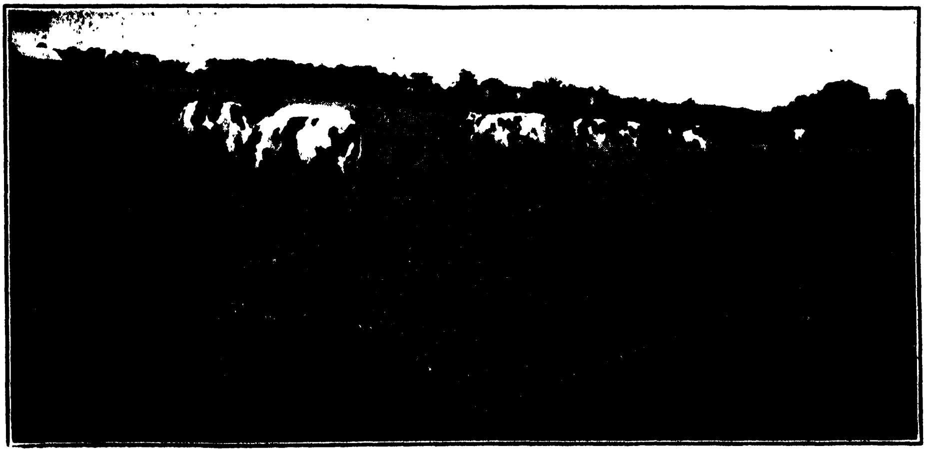
Cutting Hay Crop Reduces Soil Improving Value.—Sweet clover stores a large amount of nitrogen and organic matter in the roots during October — in fact, the weight of roots and pounds of nitrogen stored usually double from September 20 to freezing weather. If the hay is cut there is no recovery of tops and this storage does not take place. As a six-year average, sweet clover from which hay was cut in the fall contained less than half as much nitrogen and organic matter to plow under the following spring as the same plots not cut for hay. Plots cut for hay are slower to start in the spring, so that fields cut for hay can not be pastured as early as those not cut.

This does not mean that we should never remove the fall hay. On many soils, root growth is great enough by late September so that the hay is worth more than additional root storage, but where maximum soil improvement is wanted, the hay should not be cut.

The stand is not directly injured by taking off the hay crop. Sweet clover forms large crown buds in the fall which produce the next season's growth. After these are well formed, taking off the first season's growth does not kill the crop. However, removing the cover and reducing the growth of roots may and usually does lead to greater losses of stand by heaving. In the spring of 1926 and 1927 sweet clover cut October 1 averaged 68 per cent heaved while that not cut averaged 24 per cent heaved.

Second Year's Crop Ill-Suited for Hay.—The second year's growth is as hard to use as hay. Sweet clover rapidly becomes coarse and stemmy as it comes into bloom, so to secure good hay it must be cut before the blossoms appear. This is in late May or early June, which is not usually good haying weather. The leaves shatter very easily. The succulent stems may contain as much as 85 per cent of water, and so are slow to dry. All things considered, one can not recommend depending on the second year's growth of sweet clover hay. However, it is good hay whenever it is possible to get it well cured —equal to alfalfa in every way except that it is coarser. There is no difficulty in getting stock to eat the hay.

Cut High the Second Year.—Furthermore, the plants must be cut high the second year or they will be killed. After the crown buds have started in the spring of the second year, sweet clover never sends out new shoots from



Fat cattle feeding on Montgomery County, Ohio, sweet clover. This is surely a land flowing with milk and honey.

the crown as do alfalfa and red clover. The second crop must come from living buds on the stems. No definite height of cutting can be given, but it must be high enough to leave two or three green leaves and branches on the stubble. This will be from 6 to 20 inches high, depending on when the clover is cut and the thickness of the stand. In a thin stand the plants can be cut lower without being killed than in a thick stand. After the plants are in bloom it is hardly possible to cut them and have a satisfactory second crop. For this reason it is rarely practical under Ohio conditions to get two hay crops or a hay crop and a seed crop the second year.

In order to cut the sweet clover high, some use special shoes of strap iron or 2 by 8-inch lumber under each end of the cutter bar on the mowing machine. Others use the grain binder, setting the bundles in shocks of two or four to cure. Sometimes good hay is produced in this way, but it may mold before it is cured.

Disease from Moldy Sweet Clover Hay.—Experiences in Ontario, Minnesota, North Dakota, and a few in Ohio show beyond any doubt that some moldy sweet clover hay will cause a serious disease in cattle. The first symptom is the loss of the clotting power of the blood, so that the animals may bleed to death from minor accidents or operations such as dehorning and castration. Later the animals will develop internal hemorrhages resulting in soft swellings in various parts of the body. By the time this stage is reached the disease is usually fatal. However, if the animal is not too weak, a cure can be effected by discontinuing the hay and giving good care. Medication is of no value.

This disease is extremely uncommon, almost unknown, following the use of first-year hay. But when this difficulty is added to all the others in using second-year hay, it seems that Ohio agriculture would be better off if no second year sweet clover were used for hay. At the same time, it should be understood that not all sweet clover, or even all moldy sweet clover hay, causes this trouble. It has seldom been known to occur on sweet clover pasture, and then only from decayed material in the bottom of heavy pasture.

REQUIREMENTS FOR GROWING SWEET CLOVER

Because sweet clover is a common roadside plant, many make the mistake of supposing that it is of the easiest culture. There have been many failures to secure a stand of sweet clover, and there will be unless certain requirements are met.

Lime for Sweet Clover.—Before seeding sweet clover the soil should be tested, and, if acid, its lime requirement should be met by applying lime in some form. Usually in western Ohio 1 to 2 tons of ground limestone will be sufficient. Much larger amounts will be needed on most soils in eastern Ohio. It can not be too strongly emphasized that on hundreds of thousands of acres this is the factor which will mark the difference between success and failure.

On soils which are acid in the surface, but underlaid with limestone gravel at rather shallow depths, as are many western Ohio soils, light liming, that is, the application of 300 to 600 pounds of fine limestone through the drill with which the seed is sown in small grain, often gives excellent stands, and economizes in the use of limestone.

Inoculation.—As with most new legumes failure to inoculate the soil or seed accounts for many sweet clover failures. Any soil which requires inoculation for alfalfa requires it for sweet clover, since they have the same strain of bacteria. It is not safe to assume that a field is inoculated because sweet clover is growing along the road beside it. It may be, but since failure will result if it is not, and artificial inoculation is simple and cheap, inoculation should always be practiced when seeding sweet clover for the first time on a field. Soil from an established alfalfa field or roadside sweet clover patch may be used by moistening the seed and then thoroughly mixing 4 or 5 pounds of soil with each bushel of seed, so that every seed is smeared with soil.

Sweet Clover Responds to Phosphorus.—To many it will seem absurd to fertilize a crop grown for soil improvement, but there is no more economical way to get the most out of it. On poor soils a liberal application of superphosphate may double the yield of the sweet clover in addition to increasing the yield of the small grain in which it is sown. Ballou reports a test in southern Ohio in which an application of 200 pounds of superphosphate increased the yield of sweet clover by three times. Its soil building value was of course multiplied by the same figure. On some very poor soils, liberal amounts of both phosphate and potash have proved valuable.

SEEDING PRACTICES

What is Scarified Seed?—A very large share of sweet clover seed as usually harvested will not germinate at once when sown. This is due to the presence of from 25 to 90 per cent of "hard" seeds. These are seeds which have a waterproof seed coat, and when planted in moist earth they do not take up water and sprout for months or years until the seed coat has decayed or been broken by freezing. A process, known as sacrification, has been devised to break this seed coat. It consists of blowing the seed over coarse sandpaper at a very high rate of speed, thereby scratching the seed coat enough to allow water to enter more easily. By this treatment from 80 to 95 per cent of the seed may be made to germinate.

Scarified seed, or at least seed of high germination, should always be used except for seedings during or before freezing weather. Scarified seed should not be sown on honeycombed ground, since it germinates too quickly and the seedlings may be killed later. Freezing has somewhat the same effect on the seeds as scarification, and unscarified seed can be used if it is sown at a time when it will be exposed to freezing.

Methods of Seeding.—The usual rate of seeding is from 10 to 12 pounds of scarified seed, or 20 pounds of seed in the hull, per acre. If it is being grown for seed, considerably less seed may be used. When sown in wheat, sweet clover may be sown in any way that red clover is. Recent experiments suggest that a good way to obtain a stand of sweet clover in wheat is to sow unhulled seed, or at least seed with a high content of "hard" seeds any time from wheat seeding time until late in February. Scarified seed may be sown in wheat with a drill as early as the ground can be worked or broadcast just a little later than red clover would usually be sown. The best date is about March 15 to 30 in central Ohio.

When sown with oats it is usually sown from the grass seed attachment on the drill as the oats are sown, or broadcast just after seeding the oats. Covering too deep should be avoided. The sweet clover frequently grows tall enough so that it is cut with the oats and makes the bundles cure slowly. If this difficulty becomes too pronounced on especially favorable soils, it can be avoided by sowing the sweet clover a week or ten days after the oats are sown.

Use Nurse Crop for Spring Seeding.—When sowing sweet clover in the spring, some nurse crops should usually be used, as sweet clover does not compete strongly with weeds and when sown alone in the spring it is likely to be killed out by weeds. Any of the small grains may be used as nurse crops, and all have given satisfactory results. Perhaps the safest nurse crop for Ohio conditions is an early variety of oats, such as Fulghum or Sixty Day. Barley is equal-

ly good where it is grown. Wheat is the most common nurse crop in Ohio, but in nearly every instance where wheat and early oats have been compared a better stand has been secured in the oats. Even late oats have been superior to wheat in some seasons, though markedly inferior to early oats or barley.

Summer Seedings.—Summer seedings may be made alone or in corn. For seeding alone the seedbed should be firm and moist. It is rarely safe to seed later than August 15. Seeding sweet clover in corn at the last cultivation has about an even chance of success. In a dry season it will not amount to much, but when sown early in a wet season remarkable growths are sometimes made. Yellow sweet clover is probably preferable to white for summer seeding.

Mixtures Containing Sweet Clover.—Often, a mixture will be better than sweet clover alone. On land which is not uniform in reaction, 6 pounds sweet clover, 2 pounds alsike and 3 pounds timothy has been a very satisfactory mixture. The timothy and alsike occupy the acid spots where the sweet clover fails and are far preferable to the weeds which would otherwise fill these spots. Where it is intended to make hay the second year, alfalfa may be valuable. The first cutting will be very heavy mixed sweet clover and alfalfa. The sweet clover will be killed by the cutting, and the next two cuttings will be pure alfalfa. In general, however, alfalfa alone is preferable to any sweet clover mixture for hay.

For seeding permanent pastures sweet clover may be sown with bluegrass, timothy, or brome grass, and as the clover dies out it is followed by a surprising growth of the grasses. Four pounds of bluegrass, 6 pounds of timothy, and 8 pounds of sweet clover would be a suitable seeding for most Ohio soils. Timothy should always be sown with sweet clover that is to be pastured through the second year. When the sweet clover dies the timothy, fed by the decaying sweet clover, makes a fall growth which adds materially to the amount of pasture for season. However, dense growth of sweet clover may kill out any of these grasses, especially in dry seasons.

THE SEED CROP

A Prolific Seed Producer.—An important advantage of sweet clover is that it produces seed liberally whenever it is grown. The yields of seed range much higher than alfalfa and other clovers if the crop is handled to avoid shattering. The average is from 4 to 6 bushels per acre, and from 10 to 12 or more bushels are not uncommon. For this reason the seed can never be permanently high-priced, and usually it will be, as now, the lowest-priced clover seed on the market. The cost of seeding this crop is lower than for any other legume.

Pasture or Clip the Intended Seed Crop.—Seed is produced by the second year's growth and is usually ready to harvest late in August. The plants are usually from 5 to 8 feet high and hard to harvest. Some secure a less vigorous growth of the seed crop by clipping the early growth, cutting a hay crop or pasturing. Clipping must be done high, early and carefully. Even then it will often injure or kill the stand. Because of this danger, most seed growers simply let the season's growth mature. A grain binder stripped merely to clip the tops and let them fall has been successfully used to clip the seed crop in some sections. Perhaps the safest method of securing a finer stemmed seed crop is to pasture until June 1, but even this will usually reduce the yield.

Cut When Two-thirds of the Pods are Brown.—The seed does not ripen all at once. Indeed there are usually ripe seeds and flowers on the same plant. Since the seeds shatter off as they ripen, it is never possible to secure the entire yield. The best time to cut is a matter of nice judgment as to the time one can secure the most ripe seed. The novice is more likely to let it go too long and lose his best seed by shattering than to cut too soon. As near a rule as can be given is to cut when two-thirds of the pods are brown.

Cut With the Grain Binder.—There are two main difficulties in harvesting sweet clover. They are the coarseness of the crop, making it hard to handle, and the ease with which the ripe seed shatters. Probably the best method of harvesting is with the grain binder, cutting on a damp day or early in the morning before the dew is off, in order to avoid shattering. For large acreages it may be necessary to cut at night. This is unusual, but is worth while because the damp plants pack and go through the machine better than in the daytime, and there is almost no shattering. If cut with a binder in daytime it is practically necessary to have sheet iron pans under the binding head and under the end of the platform to catch the shattered seed.*

Other methods of cutting are with a mower, which shatters most of the seed; with a corn binder, which takes too narrow a swath; and with a self-rake reaper, which is fairly satisfactory but which few people have. None of these methods are as good as the grain binder for Ohio conditions.

The bundles may be shocked in narrow shocks without capping, but usually it is preferable to lay the bundles on the stubble, merely arranging them for easy pitching when they are hauled in. This causes less shattering of seed from handling and by insects.

Recently, several modifications of old grain binders into combined harvesters and threshers of sweet clover seed have been devised, and are said to do very satisfactory work. Plans for making such a device can be obtained from the Department of Agricultural Engineering, Ohio State University.

Threshing Sweet Clover.—Sweet clover is best threshed from the field, as it loses seed easily every time it is handled. If the wagons do not have perfectly tight bottoms they should be covered with canvas to catch shattered seed. The grain separator is the most satisfactory machine on which to thresh sweet clover. The clover huller may be used, but the straw is so coarse that the huller does not handle it well. However, the separator may not hull the seed, and the seed must either be put through a cover huller, or a combination huller and scarifier. The latter machine will hull the seed and can then be used to scarify it for market. Some separators with hulling attachments are on the market which give satisfactory results in threshing sweet clover.

The straw is not very valuable for feed, but is perhaps equal to corn stover. It makes excellent bedding and manure.

SPECIAL USES OF SWEET CLOVER

Sweet Clover Silage.—The difficulty of utilizing the first crop of sweet clover the second year has led to many experiments in using it for silage. As yet this method of utilization is practically unknown on Ohio farms. According to the report of those who have tried it, sweet clover makes better silage than any other legume, as it does not usually become slimy and ill-smelling as do most legume silages.

Sweet clover for silage is harvested with the grain binder and then cut up as is corn. It usually is harvested just after coming into bloom, or earlier, if a second crop is desired. One precaution is necessary. The bundles must be allowed to wilt for a while in the sun before being put in the silo. Sweet clover as cut may contain from 80 to 85 per cent of water, while to keep best, the silage should contain only from 60 to 70 per cent of water. Unwilted sweet clover put in the silo will drain out con-

*See Farmers' Bulletin No. 836, which can be secured from the United States Department of Agriculture, Washington, D. C.

siderable juice and the silage will be sour and ill-smelling. The yields will average about 10 tons of silage per acre.

Sweet Clover for Bees.—The oldest use for sweet clover in the United State is as a honey crop. Beekeepers sowed the seed in waste places for years before farmers thought of using it otherwise. Sweet clover will produce more honey than any other crop, and the quality is of the highest. The presence of bees in turn is favorable to large yields of seed.

Sweet Clover as a Weed Eradicator.—The dense growth of sweet clover the second year makes it aimost impossible for broad-leaved weeds to develop in it. One of the best methods of fighting Canada thistle and similar weeds is to allow vigorous sweet clover to grow undisturbed the second year.

SWEET CLOVER, WHITE ANNUAL OR HUBAM.—This is the same as the white biennial except that it matures in one year from the seed and has a different root formation. On top of the ground both the biennial and the annual, when fully matured, look and are exactly alike and

These Medina fields of biennial clover above, and of Hubam clover at the right, were both planted June 17, and photographed October 18. Note the difference in growth.

yield the same amount of honey, but in the first or same year, one, the biennial, will be a mere shrub about a foot high with no bloom, and the other, the annual, will be head high and in full bloom. See the two cuts.

The fact that this new legume would make such a showing in one year developed a furore of enthusiasm among beekeepers and farmers. When it was introduced, in 1920, by Prof. H. D. Hughes, of the Farm Crops Division and plant wizard of the Ames Agricultural College, Iowa, there was a great scramble for the seed. It brought as high as $20.00 a pound. The price rapidly declined to a dollar a pound. Through all of this scramble to sell seed at high prices, Prof. Hughes, although he could have made a small fortune from his discovery, kept himself entirely free from the commercial exploitation of the seed. He made the statement at the time that the public was expecting too much from this new legume, and he was afraid that some were doomed to disappointment. His prophecy came true.

While it was fully believed in the early 20's that this new annual would crowd out the biennial white and yellow, the fact stands out that it did not. There were three good reasons for this: First, the new annual in northern localities could not and did not mature the seed unless it was planted very early and that did not seem practicable in most cases on account of spring rains that would wash out the seed before it could catch. In other words, the new sweet clover, or Hubam, would not in the North produce volunteer crops like its near relative, the biennial, because the seed was not ripe enough to germinate. In the southern states, where the seasons are longer, this difficulty does not occur. Second, it is apparently more difficult to get a catch from the annual than from the biennial. The young plants of the former would easily choke out by weeds unless planted in rows and cultivated like corn. The biennial could germinate as soon as frost was out of the ground because this seed was in the soil from the season previous.

In this connection it should be explained that the biennial white or yellow would mature and the seed drop into the soil by the last of August. It might spring up in the fall or not until the next spring. The annual, on the other hand, would not mature even up to frost for most localities, and by that time the seed would not

ripen enough to germinate the following spring. Third, perhaps the most potent reason for the Hubam clover not crowding out the biennials was because its root system did not improve the soil to the same extent as its near relative, the biennial white.

Still a Future for the Hubam Clover

The annual sweet clover or Hubam will probably have a comeback as soon as its merits are fully understood. Whenever oats or winter wheat fail because of lack of early spring rains, Hubam can often be put in to furnish pasture or hay for cattle. Either the biennial or the annual give a fine pasture and it is the pasture value that has forced so much sweet clover over the country during drouths, as explained under the head Sweet Clover. Either of the sweet clovers, particularly the biennial yellow, will make a fine hay if cut early enough before the stalks become woody. Hubam will make a fine plowunder crop in the fall. Even if not mature it will make a better humus.

Why Hubam for Beekeepers

Beekeepers should be interested because it yields clear up to frost and even after the first frost sometimes. The biennial sweet clover is out of bloom by the middle of August. Plantings of both annual and biennial sweet clover carry the sweet clover honey flow from July to frost. Beemen should get their farmer friends to put in both clovers even if they are obliged to furnish the seed.

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TEMPERATURE.—In bee culture, temperature is one of the most important factors with which the beekeeper has to deal. The more nearly he can hold it to the exact point, the better he will be able to bring about certain desired results in the business.

Under the heads of Ventilation and Swarming is shown how the bees keep down the internal temperature of the hive during hot weather by an elaborate scheme of forced ventilation. One set of bees, by means of a vigorous fanning of the wings, force air into the hive; and another set, working in collaboration, drive foul and heated air out. Under Moving Bees, the importance of giving plenty of ventilation by means of wire screens to keep down the internal temperature of the hive is shown.

Under the head of Bottling Honey it will be noted that temperature plays an important part in preventing the granulation of liquid honey. If it is too high, the delicate flavor of the honey will be injured. If it is too low, granulation will take place soon.

Under Wintering in Cellars, referring to the temperature of the cellar it is explained that, in order to get the best results, the temperature should show not below 40 nor above 60 degrees F. In some cellars 45 degrees give the best results; in others, 50; and still others, 55.

The Temperature of the Cluster in Winter

Up to the year 1911 various erroneous notions were current. Some authorities stated that the internal temperature of a colony in winter was blood heat; that when the cluster was broken into, no matter how cold the day, the individual members would rush out, apparently just as active as at any time during the summer. Others held that bees went into a winter sleep, somewhat analogous to a condition of semi-hibernation or even perfect hibernation.

Still others maintained that bees during winter could and do go into a state approximating death; that they had broken into their clusters and found them lifeless; had carried them into the house and put them near a stove, and found that they soon revived and flew about the room as lively as ever. From this they argued that bees were like ants in that they went into a state of perfect hibernation. This, of course, is a mistake.

Others, again, held that the winter temperature of the cluster dropped down to about 60 degrees F. and remained at that point until the weather warmed up, when the bees would arouse.

The fact is, there is truth in all of

these assertions. The different observers had taken the temperature of the clusters at different times during the winter and under different conditions. The temperature of the honeybee cluster varies all the way, according to conditions, from 32 F., which would shortly result in death, to 97, which would be summer temperature. Whenever the cluster is chilled through, so that each individual member of it is stiff and cold, and apparently lifeless, it will soon die unless the weather becomes warmer. If one were to dig into such a brood-nest and find such a condition, he would naturally argue that bees hibernate like ants and flies.

There was quite a school of beekeepers who, in the early days, argued in favor of reducing the surrounding temperature until the bees were chilled through, because they said that in such a state they would consume almost no stores. Unfortunatey for this argument, experience shows that in a chilled condition bees can not live more than a week or ten days. Any time within that period they may or may not be revived by placing them in a warm room. If a cluster is chilled clear through in an outdoor colony, and it warms up outside enough so that the internal temperature of the hive reaches between 60 and 70, the bees may revive, move to the portion of the brood-nest where their stores are, and may, if the winter is not too severe from that time on, live through.

When the conditions are such that a cluster will chill through during the middle or early part of the winter, the owner may rest assured that the bees will die. When he comes to open the hive in the spring he will find a perfectly formed cluster with every bee dead.

On the other hand, when a colony is properly housed, and strong enough, there will be no danger of the cluster's chilling through. It behooves the apiarist, therefore, to have strong colonies and then place them in a good cellar or in warm double-walled hives or packing-cases. (See Wintering Outdoors and Wintering in Cellars. See Food Chamber and Spring Management.)

While one desirous of getting the temperature of a colony of bees during mid-winter thrusts a common thermometer down into the cluster, he is misled. In an hour or two after inserting the instrument he will probably find the mercury standing at about 97, for breaking into the hive and thrusting something down into the cluster of bees arouses them so that the temperature rises rapidly till it reaches 97. He concludes that the temperature of the winter cluster is 97, for has he not seen it with his own eyes?

If, again, he were to put a dairy thermometer into the center of the cluster, allowing the upper part of the instrument to project through the packing material, and allow it to stand, he would get a more correct reading, but not until the bees have gone back into the quiescent state previous to their disturbance. They might never go back; but in most cases a temporary disturbance does no harm, and a cluster of bees will resume its normal course. If in a day or two after the insertion of the thermometer the cover is lifted gently so as not to disturb the bees, and if the thermometer sticks up through the packing, so that it is not necessary to uncover the cluster, a fairly correct reading may be secured, provided the cluster in the meantime has not moved. The temperature may then show as low as 57. If it is lower, the bees will proceed to raise the temperature of the cluster in a manner that will be explained further on.

In this connection it should be stated that the common mercurial thermometers are not always correct; and, what is more, it is not always possible to place them so that they will be in the exact center of the cluster; and even when they are so placed the bees may move from one portion of the brood-nest to another. As fast as stores are consumed in one portion the cluster will move to a fresh supply, provided it is not too cold.

It is not difficult, with these general facts before us, to understand how various observers have been deceived in forming conclusions in regard to the temperature of the honeybee cluster during winter. It is also very evident how one might jump to the conclusion that bees hibernate like ants.

It was not until the Bureau of Entomology, Washington, D. C., attacked this problem in 1912, 1913, and 1914 that the matter was definitely cleared up. Dr. Burton N. Gates, then Apicultural Assistant in the Bureau of Entomology, Washington, D. C., made a series of experiments in determining the temperature of a colony in winter. His investi-

gations are described in Bulletin 96, U. S. Department of Agriculture. These experiments were carried on further by Dr. E. F. Phillips, Apicultural Investigator in the Bureau, and by Geo. S. Demuth, and recorded in Bulletin No. 93, Department of Agriculture. Dr. Gates worked with mercurial thermometers, but because of the limitations of these instruments he was unable to carry his work to a finish.

Phillips and Demuth conducted a series of experiments in wintering bees in a constant-temperature room at the University of Pennsylvania, Philadelphia, during the winters of 1912 and 1913, and 1913 and 1914. Several colonies variously prepared were placed in a constant-temperature room, where the temperature was held by means of coils of pipes containing a brine solution—much the same apparatus that is used in cold-storage plants. On the roof of the building containing this room there were placed several colonies of bees where the conditions of outdoor-wintered colonies could be observed. A series of electric thermometers or "thermo couples" were placed in one of these colonies on the roof and likewise in the colonies in the constant-temperature room before mentioned. By an elaborate system of wiring, these electric thermometers were connected to an observation room in the building, entirely separate and distinct from the constant-temperature room.

It was learned that the temperature within the cluster is far from being uniform, as is generally supposed by beekeepers. "At the temperature at which other insects become less active (begin hibernation) the honeybee becomes more active, and generates heat—in some cases until the temperature within the cluster is as high as that of the brood-nest in summer." During the fore part of the readings in November and December the internal temperature of the cluster of this outside colony had a tendency to drop, as the outside temperature went down, until it reached 57 F. At that point a reaction took place; that is, the generation of heat began, and from this point it began to rise in spite of the fact that the outside temperature continued to drop. The cluster heat continued to rise until the center of it registered nearly 90 degrees. After the coldest outside temperature was reached, the outer air began to get warmer, and simultaneously the temperature of the cluster began to sag.

Dr. Gates tried these experiments at an earlier period as reported in Bulletin No. 96, and discovered a similar inverse ratio; but he did not find the exact point at which the colony temperature ceased to drop with that of the outside. Dr. Phillips and Mr. Demuth learned that this point is 57 F. When the colony is without brood, and the bees are not flying, the bees generate practically no heat until the coolest point among the bees reaches a temperature of 57 F. "At this point the bees begin to form a compact cluster; and if the temperature of the air surrounding them continues to drop, they begin to generate heat." Between 57 and 69 F. the bees do not do much in the way of heat generation.

Apparently, it is desirable to have the surrounding temperature at such a point that the internal temperature of the cluster shall not go below 57 nor above 69; but, as will be shown, the question of honey or syrup are additional factors to be considered.

In the constant-temperature room, where the mercury was kept at about 42 or 43 degrees F., it is explained that "this temperature was chosen as being nearly the one generally considered best by beekeepers." There were two colonies —one fed on honey stores and another on an inferior grade of honeydew honey, that are particularly mentioned in the bulletin. Colony No. 1, fed on honey stores, was in a constant-temperature room for 163 days, during which readings were taken hourly. At first the internal temperature of the cluster according to the chart hovered around 64 and 68. The colony fed on honeydew stores showed a higher temperature at the beginning; when up to about 76 F. it began to take a sharp rise, going up to 91 above, and on November 23 the temperature began to show a sharp drop, the line running down as low as 48 on December 10, when the colony died. Clearly the poor food caused uneasiness by reason of the accumulation of fecal matter, the uneasiness causing activity, and activity called for a greater consumption of stores. The one condition operated against the other, finally ending in the destruction of the colony. The other colony, fed on good

honey, pursued its normal course through the season.

It is interesting to observe that the normal temperature of the cluster of the colony fed on good stores only gradually increased, and this increase was doubtless due to the slight accumulation of feces. This accumulation was markedly less than that in the case of the colony with honeydew stores, not because the bees became uneasy, but because, in proportion as the feces increased, the activity and temperature of the colony increased. This increase was not enough to cause the death of the colony, but did cause a slight reduction in the force in the spring. These observations explain the importance of good food—a food that will not clog the intestines. It also explains a common cause of dysentery.

Phillips and Demuth also discovered that the length of the life of bees either during summer or winter depends on the activity of the bees. The greater the activity, the shorter the term of life.

They also found that, when brood-rearing commences or is in progress, the temperature of the cluster will rise to about that of summer or spring. This was to be expected, of course.

During these experiments a remarkable thing was learned — namely, that there can be, and actually is, activity inside of a cluster of bees during winter. When the temperature of a cluster goes down to 57, and the outside temperature surrounding the hive is dropping, the bees by actual muscular exercise can raise the temperature of the cluster. This activity may consist of a few bees tugging at each other, moving their bodies back and forth, or actually fanning with their wings. One bee may set up an active fanning inside the cluster during the dead of winter. Bees actually fan to cool themselves in summer and to warm themselves in winter, paradoxical as this may seem.

It is difficult to comprehend that bees can warm themselves up by exercise, like their owners; and the idea that their little electric fans, so to speak, can raise the cluster temperature as well as cool it seems at first absurd; but that it is true the author proved to his entire satisfaction by the experiments he conducted during the winter of 1914 and 1915. He used a hive that had double glass sides. The bees were compelled to form their winter clusters against these sides. It was thus possible to watch the internal movements that actually took place inside, and what was seen was indeed a revelation.

Various observers have opened up clusters of bees in midwinter, and found the bees inside in any cases as active as they ever are. Similarly, thermometric readings have sometimes shown the temperature the same as during the summer. In the light of the observations taken by the Government, it is very easy to explain this, notwithstanding that there are times when the temperature of the cluster is below 60 to 70. One has only to remember that, when the inside temperature of the cluster goes as low as 57, the bees raise the temperature of the cluster even though the outside temperature is becoming colder and colder. The presumption is that, when the cluster is large enough, they keep up these "daily exercises" in order to keep the cluster warm. A prolonged cold spell, especially that down to zero, is nearly always disastrous to good wintering. This cold weather puts the bees in the cluster in a state of activity; and activity causes an abnormal consumption of stores, with no means of voiding their feces, and then dysentery follows; hence after a prolonged spell of cold weather that has lasted for weeks, we commonly find evidence of dysentery.

At the close of this bulletin the authors make this obvious statement that "bees in winter, either in cellars or outdoors, should be disturbed as little as possible."

THISTLE—See Canada Thistle.

TONGUE MEASUREMENTS OF THE HONEYBEE*—The discussions on tongue length of the honeybee which were published in the American bee magazines around 1900 were received by American beekeepers with a great deal of interest and enthusiasm. The measurements on tongue length conducted by investigators of that time were taken on so few specimens that their findings were inadequate to be considered authentic from a statistical viewpoint. Another factor which possibly explains why these discussions ceased is that statistical methods were not well enough known to biologists to enable them to avoid certain errors.

In discussing the various aspects of

*.03937 inches equals 1 millimeter. If the reader desires to interpret the millimeter measurements given in this paper in terms of inches, divide the millimeter reading by .03937.

tongue length, the writer will confine himself largely to investigations which deal with a large number of measurements to which statistical methods have been applied. Much interest has been

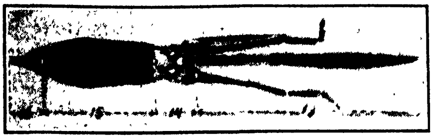

Fig. 1.—Measurements on the tongue. (13) Ligula of the proboscis. (14) Distance from the distal end of the mentum to the narrowing on the ligula. (15) Length of the mentum. (16) Length of the submentum. (From Alpatov.)

shown in Russia on measurements of bees. The celebrated work of Chochlov, Michailov and Alpatov of that country are undoubtedly among the greatest scientific studies contributed on the measurements of bees.

Different Bee Races Have Specific Average Tongue Length

Chochlov's work in 1916 was a distinct contribution on the biometry of the honeybee. His work covers measurements on six races of bees, each race being represented by three colonies, with a total of 1899 specimens examined. From this work he concluded that each different race of bees has a specific average tongue length. Another Russian worker, Alpatov, has been accumulating a vast amount of data since 1924 on this same subject. The writer will refer to that part of his work which relates to tongue length. Through the granting of a research fellowship from the International Education Board, Alpatov was afforded an opportunity to carry on his studies in the United States and spent the summer of 1927 at the Apicultural Laboratory at Cornell University. In this country, in measuring the tongue length of black bees, Italians from Italy, and Caucasians from Colorado, he found that his results verified Chochlov's work, i. e., different bee races have specific average tongue lengths. Fig. 2 represents graphically the variation of the tongue length of the three races of bees studied. As is obvious from Fig. 2, Italians have considerably longer tongues than black bees. In carrying on studies on American Italians, Alpatov followed the course of making tongue measurements on fifty bees taken from ten colonies from each of various apiaries. His studies show that the variability of the tongue length of the American Italian bees is not uniform in different apiaries; i. e., a Kentucky apiary gave only 6.166 mm. with a probable error of .011 mm.,

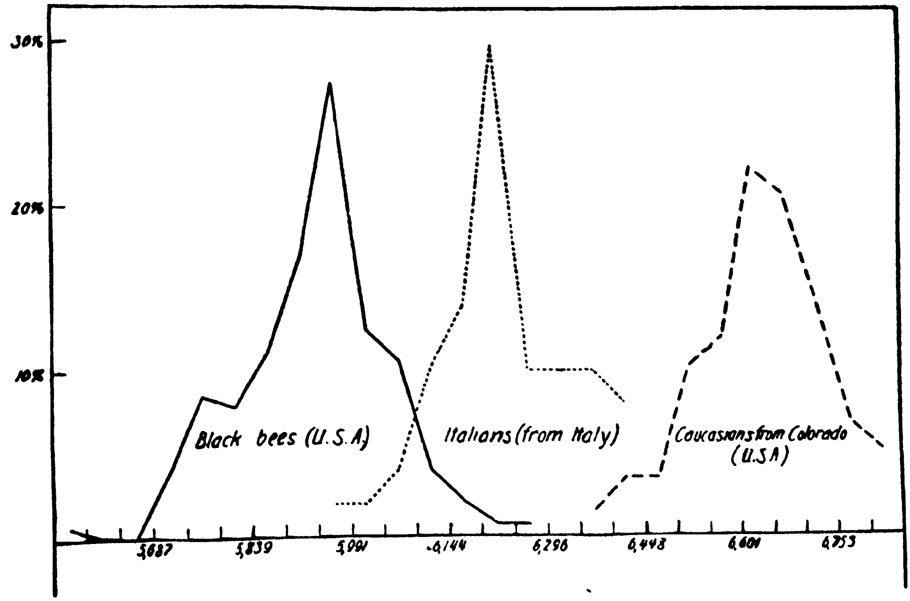

Fig. 2.—Variation curves on tongue length of different races of honeybees. (From Alpatov.)

while the two Ohio apiaries show the longest tongue length, 6.419+—.012 and 6.396+—.013 respectively. Because of an insufficient number of measurements, Alpatov declines to draw any comparative conclusions on the relative tongue lengths of Italian bees reared in the United States with native Italian bees, except to sum up his data in stating that the average tongue length of different strains of Italian bees varies from 6.15 to 6.45 mm. Of all the races of bees studied the Caucasian bees had the longest tongue length.

Geographical Variations in the Tongue Length of the Honeybee

The notable Russian work on the geographical variation in the tongue length of the honeybee conducted in the plains area of European Russia is the only authentic research on this angle of the biometry of the honeybee. These investigations were not confined to the plains of European Russia by chance, but for very good reasons; namely, this region covers a large expanse in square miles where

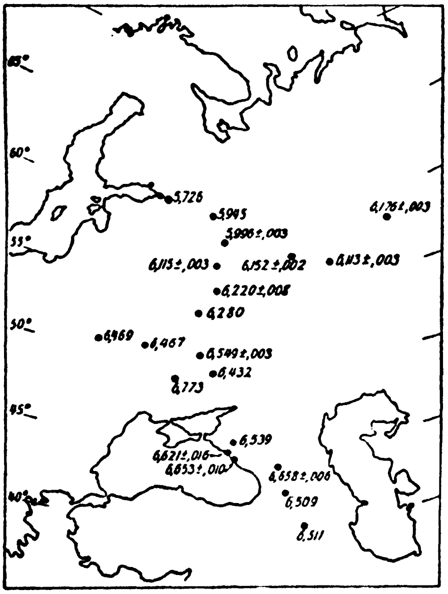

Fig. 3.—Map on European Russia and the Caucasus, showing the average tongue length of bees from different localities. (From Alpatov.)

climatic factors change gradually; transportation facilities are limited, thus reducing the moving of bees within the area and furthermore the Russian plains have always been under one rule of government.

Michailov's studies on bees were the first evidence gathered that there might be a geographical variation in the measurements of the various parts of the honeybee. The data gathered by this investigator in 1924 show that tongue lengths varied in different areas and also that in the plains of European Russia there is a regular increase in the length of the tongue from the north toward the south.

In 1924 Alpatov began an exhaustive study on the biometrical measurements of bees from all parts of Russia as well as extending these studies to the United States. Fig. 3 summarizes his work on the average tongue length of bees in the plains of European Russia and the Caucasus region. The tongue measurements are expressed in terms of millimeters, and the + — indicate the probable error when

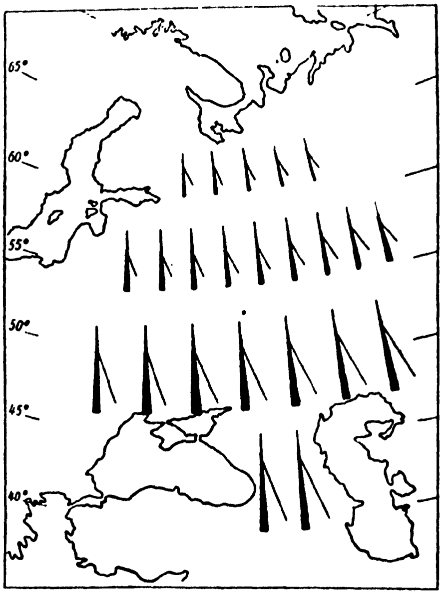

Fig. 4.—The vertical bars with broad bases represent the tongue length. The lines attached to the right side of the bars show the proportion of legs to body size. (From Alpatov.)

data were taken from five or more colonies in a specific locality. The measurements show that the average tongue length of bees differ in neighboring localities, yet comparing the measurements from the most northern point toward the south, there is a marked increase in tongue length. This illustrates clearly that there is a geographical variation in the tongue length of the honeybee. The symbolic illustration in Fig. 4 shows in another way

the gradual increase in tongue length from north to south. Along with this change in tongue length were other changes in the measurement of the body of the bees. Figure 5 shows Alpatov's

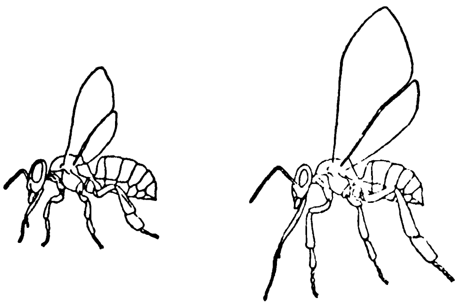

Fig. 5.—Schematic representation of the northern and southern constitutional type of bees. (From Alpatov.)

schematic representation of the northern and southern constitutional types of bees. It is evident from this illustration that with an increase in tongue length there is also an increase in wing and leg length.

Influence of Different Environmental Conditions on Tongue Length

Michailov's work stands out as one of the great contributions on this perplexing study. His work dealt with a large number of measurements on which statistical methods were applied so that the results should be considered rather significant. In taking measurements he checked five morphilogical characters among which was included tongue length. His studies on the influence of different environmental conditions may be classified as those relating to seasonal variation of the honeybees; the influence of temperatures during the development of sealed brood; size of cells; nutrition; influence of age of the imago on the dimensions of the body; and the strength of the colony. His results may be summarized by stating that the tongue length in a colony of bees was usually greater as the season advanced; tongue length of bees emerging from sealed brood incubated at 35 degrees C. was longer than where the brood was incubated at a lower temperature; and tongue length was greater in worker bees reared in drone cells and white comb than worker bees reared in dark combs containing worker cells. Alpatov's work showed that bees reared from underfed larvae had shorter tongues than larvae fed under normal conditions. In the phase of the work relating to colony strength and tongue length Michailov gathered data from 23 colonies, taking 200 individual specimens from each colony. These colonies were classified as strong, medium and weak. He concludes that statistically he can safely say that other factors being equal, bees from stronger colonies have the longer tongues.

Long Tongued Bees Visit Flowers with Deeper Corollas

The question of varying tongue lengths is largely responsible in giving stimulus to the biometrical work on bees. In the early part of this century E. R. Root reported that he had a strain of Italian bees that worked on red clover—a plant not normally visited by bees, because of the deep corollas of the flowers. Previous to the World War a Russian agronomist, I. N. Klingen, concluded after intensive studies that visits by honeybees on red clover depended largely upon two factors: first, the absence of other nectar-secreting plants during the blooming period of red clover; and second, the presence of long-tongued bees. Klingen was an ardent advocator of gray Caucasian bees. His data showed that when hives of Caucasian bees were near red clover fields there was an increase in seed yields over fields where there was an absence of bees.

More recently an intensive study of this subject has been carried on by several experimental stations in Soviet Russia. A. F. Gubin, Director of the Moscow Experimental Station, reports on the comparative qualities of middle Russian and gray Caucasian bees pertaining to their tongue lengths, and to their activity on red clover. In the spring of 1926, nine queens of the gray Caucasian strain were introduced to nine colonies of the Moscow black native bees (middle Russian). When sufficient time had elapsed for the newly emerged gray Caucasian bees to nearly replace the native bees, measurements were made on 100 bees from each of these colonies as well as from 10 other colonies of the Moscow type. In Fig. 6 the continuous line represents the variation curve in tongue length of the bees of these colonies. In discussing the curve Alpatov states: "It is clear that the bimodal character of the curve is due to

the presence of long tongued Caucasian worker bees with an average tongue length of about 6.60 mm. At the same time on the field of clover situated near to the apiary a collection of bees visiting the clover was made. The dotted line in Fig. 6 represents the variability of bees collected on red clover. Like the continuous line the dotted curve shows two peaks,

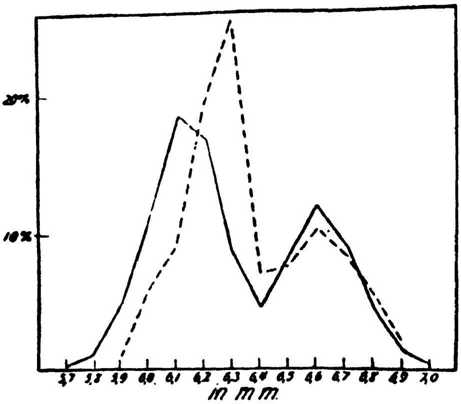

Fig. 6.—Frequency distributions of tongue length of bees. The continuous curve shows the variation of the tongue length of 1900 bees taken from 19 hives of the apiary of the Department of the Moscow District Agricultural Experiment Station. In 9 of these hives the Moscow native queens have been replaced by queens of the Gray Caucasian race. The dashed curve represents the variation of 228 bees collected near the apiary on flowers of red clover. The curves are based upon data obtained through the courtesy of Dr. A. F. Gubin, Director of the Department of Apiculture. (After Alpatov.)

one corresponding to the Moscow bees and the other to the gray Caucasians. The most interesting fact is that in the dotted line the peak which represents the Middle Russian bees working on red clover is shifted a little to the right from the peak of Middle Russian bees collected from hives. It means that the Middle Russian bees which were collected during their work on red clover have a longer tongue than the general population of Middle Russian (Moscow) bees. In other words, only comparatively long tongued bees are able to work on clover. The peak for Caucasian bees collected on clover does not show any shifting along the horizontal axis. This indicated that in the case of the Caucasians a selection of long tongued individuals did not occur. All Caucasian bees could work equally on red clover."

After studying this graph in Fig. 6, it seems quite impossible to refrain from making a few comments. It is a well known fact that bees working on flowers may be divided into three classes: those gathering pollen only, those gathering nectar only, and less frequently, those gathering mixed loads of pollen and nectar. It is quite obvious that in the aforementioned experiment were the bees gathering red clover pollen only, tongue length would not be a factor and there would be no shifting along the horizontal axis in the dotted curve. The fact that these bees had longer tongues than the general population of the Moscow bees indicates that the activity on red clover was at least a partial response to nectar gathering. Since the gray Caucasian bees were collected in the same red clover field at the same time as the Moscow bees, it is natural to suppose that the gray Caucasians were also working under the nectar gathering response. Since there is no shifting in the dotted line along the horizontal axis it raises the question of whether bees having a tongue length of from 6.5 to 6.9 mm. are not sufficiently equipped to gather nectar from red clover.

Several factors which should be given consideration on this controversial point relative as to whether bees are able to gather nectar from red clover are: tongue length, average length of corolla tube of red clover flowers, height that nectar may rise in the corolla tube, and lastly the actual tongue reach of the honeybee.

Tongue Measurement vs. Tongue Reach

A standard method for measuring the tongue length of bees has been adopted by scientific workers. The necessity of a standard method for making measurements is obvious and makes possible a comparative study of investigations carried on by various workers. Fig. 1, page 719, illustrates the underside of an extended tongue of a bee. Measurements are taken from the tip of the tongue to the base of the submentum.

When the proboscis, or tongue, of the honeybee is not in use, the part designated as the ligula is folded back on the mentum; the mentum does not extend beyond the mandibles, but occupies the ventral position of the anterior region of the head. The question arises, is the tongue measurement indicative of the distance that bees are able to reach for nectar, or conversely are bees able to reach farther

than the tongue measurement would indicate?

The preliminary studies on tongue measurements vs. tongue reach, conducted by H. C. Freshwater, at the Ohio State University during the summers of 1932 and 1933 are worthy of consideration. It seems that his approach to the problem of tongue reach is very logical as it involved taking measurements from individual living bees which were marked to establish their identity, thus making it possible to take as many measurements as were desired on the tongue reach of an individual bee and later taking the actual tongue length of the same bee after death.

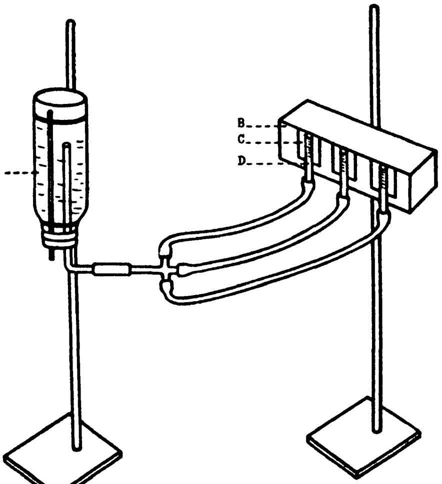

Fig. 7.—Apparatus used by Freshwater in determining tongue reach of the honeybee. (A) Bottle containing dilute honey solution. (B) Wooden block supporting the capillary tubes. (C) Millimeter scale. (D) Capillary tube with a diameter of one and one-half millimeters. (After Dunham.)

Fig. 7 illustrates the apparatus used by Freshwater in determining the tongue reach of honeybees. The dilute honey in the bottle passes through the rubber tubing to the capillary glass tubes having a diameter of 1½ millimeters. Capillary tubes of this size permit the proboscis of the bee to be extended down into the tube readily, but prevents the anterior part of the head of the bee from being inserted into the tube. As soon as the bee began to fill up on the dilute honey in the capillary tube, the bottle was lowered until the dilute honey solution was just beyond the reach of the honeybee. By looking through a large hand lens the observer was able to read on the millimeter scale in back of the capillary tube the longest distance the bee extended its tongue in an effort to reach the honey solution.

Measurements were taken on a total of 943 bees. The tongue measurements of these bees after death ranged from 5.821 mm. to 6.366 mm., while the tongue reach of these living specimens ranged from 6.05 mm. to 7 mm. In conclusion, Freshwater says he is hesitant to make any positive statements as he feels that more data should be gathered. However, he says the data would indicate that the tongue measurements of bees are less than the tongue reach.

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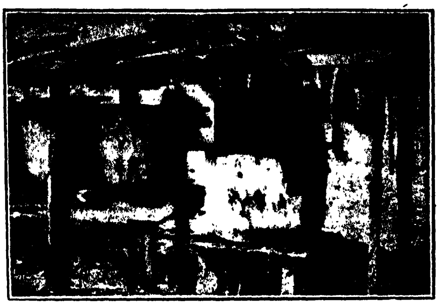
—W. E. Dunham, Agricultural Extension Service, Columbus, Ohio.

TITI.—They are shrubs or small trees growing in wet land, or swamps, and along rivers. There are three species in the southern states, which are valuable as honey plants. The honey is apparently seldom obtained pure, or in large quantities. It has been frequently described as dark-colored, and poor-flavored compared with the northern white honey. See "Honey Plants of North America."

TRANSFERRING. — The term might mean moving bees from one yard to another, or bees from one hive to another.

In the strict technical sense, however, it means moving bees from box hives, log gums, or straw skeps into modern movable-frame hives. The usual process involves the act of cutting the combs out of an old hive and fitting them into movable frames, after which they are placed in an up-to-date hive. When one, by purchase or otherwise, acquires a lot of old gums,

A characteristic log-gum apiary. There are several rows of these gums that were transferred by C. L. Sams. This is not at all a rare sight in the Southland.



The same bees after being transferred into modern hives. This apiary of 100 colonies, belonging to W. J. Martin, with the help of Mr. Sams, was easily transferred from the log gums in one weeks' time.

he must transfer them into modern hives before he can do anything. To do this he must provide himself with as many hives, with a full equipment of frames, as he has gums or old box hives to transfer.

When to Transfer

A day should be selected, preferably during fruit bloom in the northern states, when some honey is coming in, or when a honey flow is on in early spring in the South. The early part of the season is recommended, because at that time of the year there will be relatively fewer bees and a comparatively small amount of honey. If, on the other hand, the work of transferring is performed during the hottest part of the year, the gum will be full of bees and honey, and, of course, the operator will be working at a great

Log gums used for producing comb honey, with the "supers" in position.

disadvantage—particularly so if the time selected for the work be during a dearth of honey, when the bees are inclined to rob. (See Robbing.)

A day should be selected when the weather is warm—preferably between the hours of 9 in the morning and 4 in the afternoon. Sometimes it is desirable to

Log-gum apiary of J. S. Kelly, near Wilmington, N. C. Mr. Sams was holding an empty gum, and, although the bees were stinging him unmercifuly, he stood his ground while the author was "snapping" him.

transfer during a dearth of honey in midsummer. A day should then be selected when there is a slight mist or rain, as there will be no flying bees. While the bees will be inclined to sting more at such times, and the operator will have to use more smoke and proceed as cautiously as possible, there will be no trouble from robbing.

At the end of the transferring all drippings of honey should be disposed of;

and if honey gets on the grass or on the ground, a pail of water should be dashed over it to wash it away. Should foulbrood be present in the locality, the precaution of cleaning up everything in the way of sweets is doubly important.

Sometimes the box hives or log gums have to be carried quite a distance. In that case the gums should be put inside of burlap sacks and tied. They can be moved at any time, but preferably in the morning or in the evening. On arrival at their permanent home the sacks should be removed and the hives placed on the spots where the bees will be after transferring.

The methods here described are used by C. L. Sams, Bee Extension Agent for North Carolina. He has had more experience in transferring, probably, than any other man in the United States.

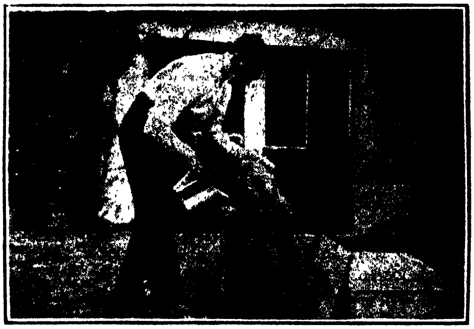
The tools necessary for transferring are a wide board, or a hive cover, butcher-knife, and a handsaw—preferably one having a narrow blade. In the case of a round gum a sort of keyhole saw with a long blade is better than a common handsaw. There should be, of course, modern hives with empty frames, frames containing full sheets of foundation, a pail of water, tin pans, and last but by no means least important, a bee-smoker, with plenty of fuel well lighted.

How to Transfer

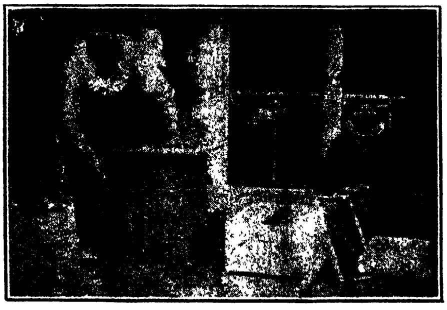
The first operation is to blow smoke into the entrance of the box hive. This is then removed a few feet from its stand and turned upside down, and more smoke is blown over the combs to drive down any bees that may be left which would resent intrusion. A modern hive with its movable frames is now placed where the box hive stood, with the entrance pointing in the same direction. This hive should contain, preferably, four or five frames having full sheets of foundation. Part of the frames should be on one side of the hive and the rest on the other, leaving a space in the center. Wherever possible a frame of brood and a little honey should be added from some other hive.

The next operation is to blow more smoke over the combs in the box hive, now upside down. As soon as the bees are driven down, some five or six inches of the combs is broken off or cut off. A super cover or any flat board or even the top of the hive is set over the box hive. A vigorous drumming, with blows not too hard, with a hammer, is now applied to the side of the box hive. This drumming is kept up continuously for eight or ten minutes, at the end of which time the majority of the bees will have crawled

Not much examination can be made of combs in a box hive. By turning the hive upside down the combs may be separated somewhat with the fingers. The lower edges of the combs are always rounded over.



Smoking the bees in the box hive preparatory to transferring. The box hive is first turned upside down, and then the smoking is begun.



Mr. Sams drumming on the hive to drive the bees up against the top board so he can remove them and cut out the combs. Courthouse officials of Wilmington, with an inborn sense of safety and a snap, look out from within.

from the combs beneath, and clustered on the super cover (now on top). During the process of drumming it is advisable to lift the cover slightly to see how the

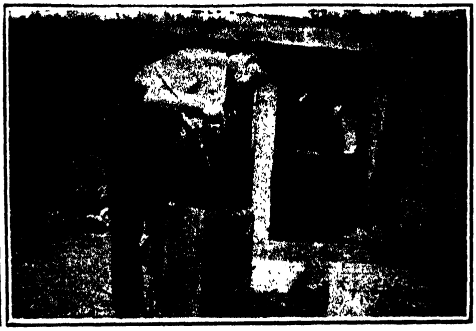
After drumming, the bees crawl upward and cluster on the super cover. This is gently placed on the new hive, after which the operation of transferring the combs begins.

bees are coming up. When a large cluster has formed, the super cover or flat board with its cluster of bees is lifted off the hive and set down on the prepared new hive in such a way that the cluster will extend down in the space between the frames as shown.

If, however, not all the bees are out of the original box hive, a second drumming may be applied with another super cover, but usually this is not necessary. If the first drumming be continued long enough there will be, of course, a few straggling bees left down among the combs. No attention need be paid to these, as they will not sting, having become completely demoralized by the drumming.

Driving the bees up into the hive direct.

Another plan that Mr. Sams uses is to nail a couple of cleats even with the bottom edge of the gum, then turn it upside down. On top of this place the new hive,



After the bees are drummed out, a common handsaw is altogether the best tool for cutting the combs away from the sides of the box.

minus the bottom-board, with a full set of frames containing foundation, the hive resting crosswise on the cleats. The old gum is then drummed on the side as before explained until all the bees, or most of them, go up into the new hive. This they will do very readily, but lift the hive up once or twice to see when the bees have gone up. It is then lifted off with its bees, and set down upon the bottom-board.

It is not necessary that the two ends of the new hive sticking over on each side of the gum be closed up, for the bees will go up just the same.

This plan has the merit that the bees are driven directly from the old gum into the new hive without the use of a super-cover or box.

The handsaw is now passed down between the combs and the sides of the box if it is a square gum. A good handsaw is better than a long knife for separating the comb; and, moreover, when it encounters the cross-sticks these can be sawn off, whereas a knife would be worthless. If the cover, now at the bottom of the box hive, has not been previously loosened, it can be knocked off with a hammer, when the box can be lifted off, leaving a mass of combs standing upright. The cross-sticks may now be easily removed by pulling them out, and the combs separated. Only those portions of the comb that contain worker brood should be saved, because experience shows that it does not pay to transfer empty combs or combs containing honey

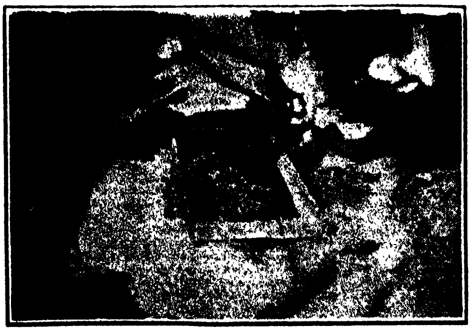
into brood frames. Those containing honey should be put into a tin pan and used on the table, while all other pieces not containing worker brood should be melted up into wax.

Proceed to insert the combs in the frames as follows: Lay a good comb of

In the case of the round gums or logs, it is necessary to use a keyhole or narrow saw, which is run clear around the inside of the log, cutting the cross-sticks.

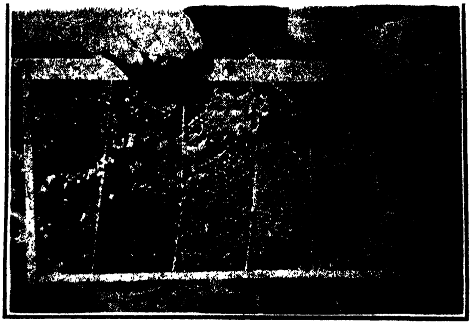
brood from the gum flat on the board or super cover. Over this lay one of the empty brood-frames. With a knife mark out the exact size of the comb. Lift the frame, then cut the comb to the desired shape and size. It is always better to cut comb a little large so it will make a snug fit, after which the brood-frame is crowded over. If the fit is good this frame of brood can be set down in the hive without any fastenings.

After several of the larger pieces containing brood have been fitted into frames as described, there will be a number of smaller ones, the brood in which it is desirable to save. Several of these pieces



Only the combs containing the brood are fitted into brood-frames. A butcher-knife marks the size of the piece or pieces to be cut, and then the whole slice is cut large so as to fit snugly into the frame.

can be laid down on the board and their edges matched. In order to make a close fit it may be necessary to trim the edges a little. After the crazy-quilt combs are fitted together a brood-frame is then laid over the hole. With a butcher-knife mark out the exact shape as previously directed, then slip the frame snugly over the combs after they have been trimmed. The whole board containing the frame and pieces of comb should then be lifted to a vertical position, as otherwise the pieces will fall out when the frame is lifted. A string is now wound around the whole several times, as shown below, when the frame is ready to be inserted with the other frames of brood. It will not pay to save very small pieces of brood. These should be dumped into the wax- extractor with other pieces of comb not containing honey.



Where there are several pieces of comb it is necessary to use strings to hold them in place. These are wound around the frames several times and tied. The bees will remove the string.

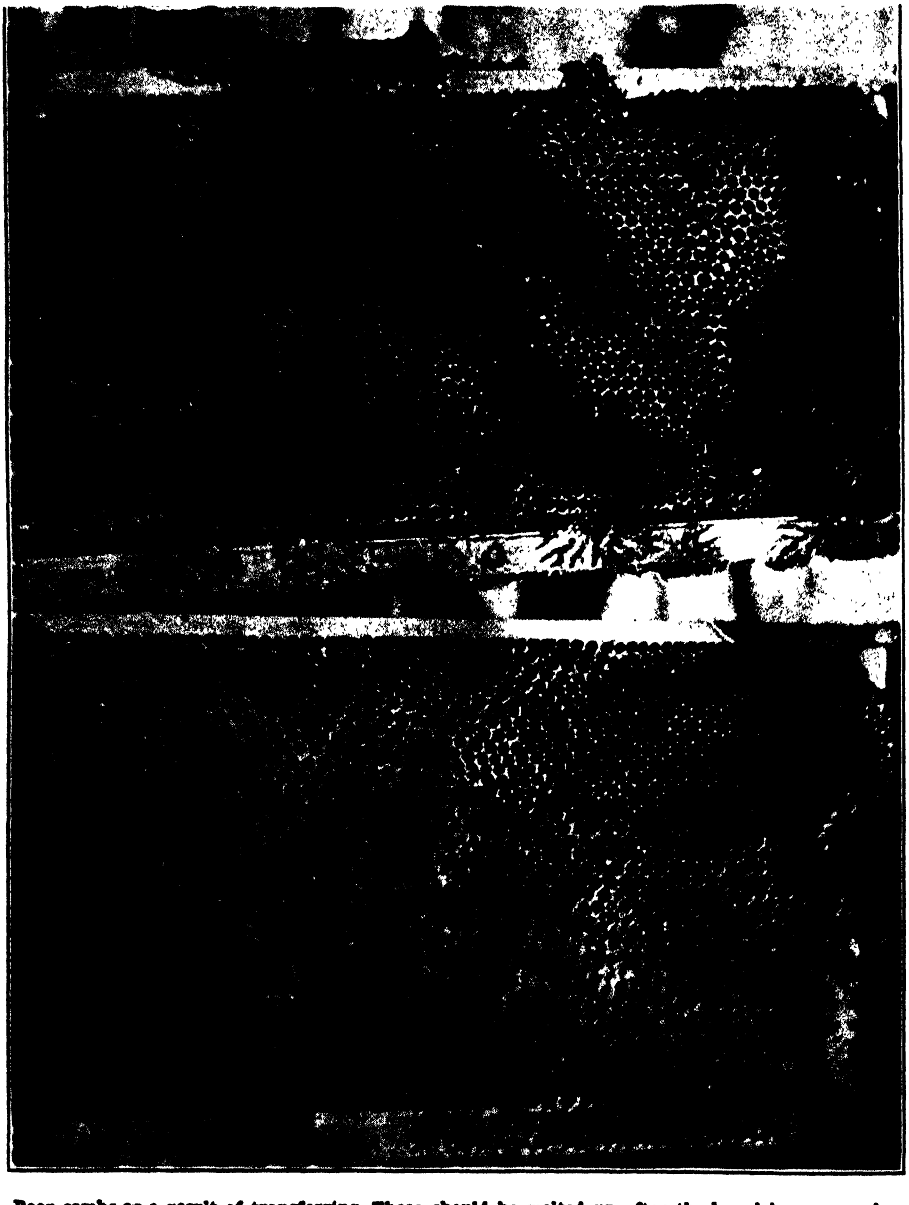
In the average box hive there will be enough worker brood to fill four or five empty frames, Langstroth size. Drone brood should be excluded. The remaining space on either side is then filled with frames of foundation — preferably full sheets.

In any case where small pieces of comb have been fitted together as shown above, the comb, after the brood has emerged, should be removed and melted up. It does not pay to keep such combs in the hive, as there will be uneven surfaces and too much drone comb. The cut on next page shows how these combs look after the brood has emerged. Notice the drone comb and where the pieces of comb in transferring were welded together by the bees. All combs should be built from full sheets of foundation wired in the frame.

Transferring Without Using the Old Combs

Another plan that is somewhat slower, but which avoids the cutting of combs of brood or honey, is as follows:

A modern hive is prepared containing nine frames of foundation and a frame of brood from some other colony. This is placed on the stand now occupied by the old hive or gum. On top of the new hive is then placed a bee-escape board with the escape feeding downward. The gum, or box hive, is turned upside down, after which five or six inches of the comb is removed. A separate cover or flat board is then placed on top. Drumming is then applied to the sides of the gum until about half the bees and the queen cluster

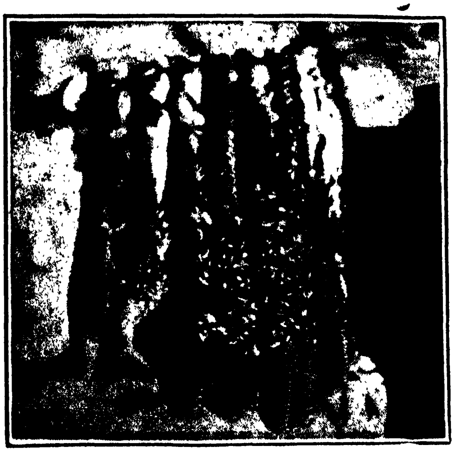


Poor combs as a result of transferring. These should be melted up after the brood has emerged.

on the super cover in the manner before explained. The bees and queen are then dumped in front of the entrance of the

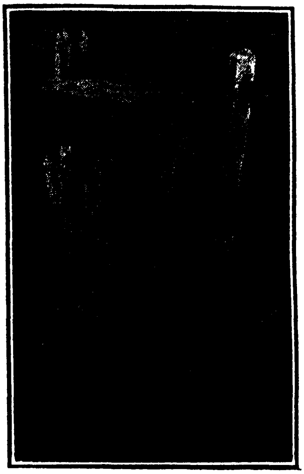
Mr. Sams dumps the remnant of bees from the box hive in front of the new hive.

new hive. If the queen is not seen running in, it will be necessary to drum until she is found. The old gum with its remaining bees is then placed on the new hive with all openings between the new hive and the gum closed except through the escape, as shown. The young bees, as they emerge with the other bees, will gradually work down through the bee-escape into the new hive, where the queen should be. At the end of three weeks there will be no bees upstairs, and nothing but old comb. The old gum is then removed, and its contents cut out and melted up into wax.



Natural combs as built in a "gum." Since the combs can not be interchanged, there is but little foulbrood in the region.

The merit of this plan is that it avoids cutting out the combs and fitting them into frames, avoids daubing honey on tools and appliances and avoids robbing. The average brood-combs in the box hive are usually very poor containing too many

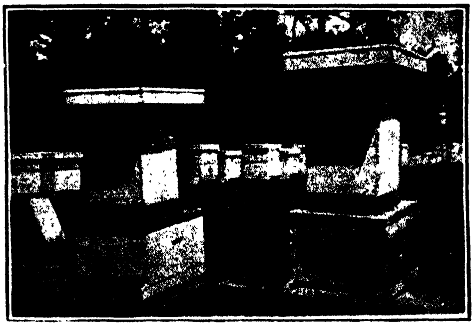


A modernized log-gum hive with removable cover, arranged to receive a super of sections.

drone-cells. They are likewise more or less irregular. For these reasons it is better not to use them.

The Heddon Short Way of Transferring

The old box hive is moved back four or five feet, when a modern hive, with a full set of combs or foundation, is put in its



This picture shows a longer way of transferring, but it avoids the necessity of cutting and fitting combs of brood into frames. The objections to the plan are the difficulty of getting the queen into the new hive and the length of time required to complete the transfer.

place. The old hive is turned upside down, after which about two-thirds of the bees are drummed onto a board or a

Flower of tulip tree.

super-cover above, in the manner already explained. In doing this drumming it is important that the queen enter the cluster. This can be determined by dumping the bees from the board in front of the entrance of the new hive. By watching carefully, one can see the queen when she goes in. If she is not discovered, more bees are drummed out of the box hive, and the second lot is dumped in front of the entrance. If the queen is found this time the old box hive should be given enough bees to take care of the brood. It is then turned right side up, and put two feet back of the new hive with its entrance turned in the opposite direction. It is allowed to stand for 21 days, at the end of which time all worker brood will have emerged, and nothing will be left but a little drone brood. All bees in the old box hive are drummed out in front of the new hive having an entrance-guard. The combs in the old hive are melted up, and the hive itself burned.

TRAVEL-STAIN.—See Comb Honey.

TULIP TREE (*Liriodendron Tulipifera*). — Other vernacular names are whitewood and yellow poplar from the varying colors of the wood, canoe wood from the use made of it by Indians, and saddle tree from the arrangement of the leaves in the bud. Its height is usually from 60 to 90 feet, but in favorable localities it may grow 140 to 180 feet tall, with a diameter of 4 to 12 feet. The tulip tree is one of the handsomest of American ornamental trees, growing in a conical form, offering an extensive shade, and putting forth in May or June an immense number of large greenish-yellow flowers. The peculiar-shaped leaves easily distinguish it from all other forest trees.

The tulip tree is found in rich woods from Massachusetts and Michigan southward to Florida and Mississippi and westward to Arkansas and Louisiana. It succeeds best in a fertile loamy soil, such as occur in river bottoms and on the borders of swamps. As a source of honey it is important in southern Virginia, West Virginia, Kentucky, Tennessee, Maryland, North Carolina, South Carolina and northern Georgia. In southern Virginia on the Piedmont Plateau the tulip tree and sourwood are the only plants which yield a large surplus. In the rugged wooded region of southwest Virginia the tulip tree, sourwood, black locust, and basswood furnish a large amount of honey. Along the Ohio River in West Virginia the tulip tree is likewise abundant.

In Maryland above the fall line on the Piedmont Plateau the tulip tree is sufficiently abundant to yield a honey crop regularly.

The honey obtained from the tulip tree is bright amber when new, but it becomes darker with age and very thick, so that it closely resembles molasses. In quality it is good, one of the best of the dark honeys. It is a kind of honey that "wears well" on the table. It is in good demand locally throughout the South. See "Honey Plants of North America."

TUPELO (*Nyssa*). White tupelo (*Nyssa aquatica*). White gum. Cotton gum. Water tupelo. Tupelo gum. Swamp tupelo. In river swamps in the coast region from southern Virginia to northern Florida, westward to the Nueces River, Texas; northward through Arkansas, west Tennessee and west Kentucky and southern Missouri to the lower Wabash River, Illinois. The small greenish flowers open in April and May. The male flower or staminate are on one tree and the female, or pistillate, are on another tree. The staminate are in dense round heads; the pistillate or fertile are solitary on slender stalks. The blue-purple fruit ripens in September. The wood is soft but can be used for crates

Sprig of scrub tupelo, showing the shape of the leaves and blossoms.

Black tupelo or gum with berries.

and packing boxes. In the older floras the Latin name of this species is given as *Nyssa uniflora*.

The honey of white tupelo has a very mild exquisite flavor, a thick body, and is very light in color with a pale lemon hue which renders it very attractive in glass containers. The bulk of this honey is produced in the extracted form. It is in great demand among northern dealers in honey, who prefer it because it does not granulate. It contains about twice as much of levulose as of dextrose. This is why it is so highly prized by people suffering from diabetes. There are not a few physicians who recommend it.

The nectar is secreted very copiously and a great amount is collected by the bees in a few weeks, but they are not numerous enough to harvest more than a small part of it.

The beginning of the honey flow is determined by the length of time the lowlands are covered by water. If there has been no overflow in early spring the trees in northern Florida will bloom in March, and the honey flow will last for three weeks. But if there has been much rain and the rivers have flooded the bottomlands, the blooming time will be much delayed. The honey when first gathered is thick, light in color, and very mild in flavor; but with age it grows darker colored and stronger flavored.

The most famous section of Florida for beekeeping is the northwestern part of the state along the Apalachicola and Ocklocknee rivers, where the white tupelo, black tupelo, and spring titi are abundant.

See "Honey Plants of North America."

U

UNITING BEES.—This term is used to refer to the putting-together of two or three nuclei or weak colonies, either from the same yard or from different yards. The operation is just the reverse of dividing, in which process a colony is split up into several smaller units. (See Dividing, Increase, and Nucleus.)

When several families of bees are put together they may or may not sting each other, depending on circumstances. If the weather is warm, and the bees are hybrids or blacks, they may, at the moment of uniting, enter into a free-for-all fight. The result, unless stopped by the timely use of smoke, may be almost the annihilation of one or both lots of bees. As a rule, even without smoke there will be no quarreling where gentle strains of bees like Italians or Caucasians are used; and even when they have these "family disturbances" they can be "adjusted" very nicely by the use of plenty of smoke. Sometimes more smoke will be needed than at others, especially if the two lots of bees are of fairly good strength, and persist in stinging each other to death.

In the cool part of the fall or after brood-rearing has ceased and the bees have formed clusters to conserve heat they can usually be united without difficulty.

In any case after uniting without smoke it is advisable to watch the bees for a few minutes to see if there is any trouble later. Many a lot of fine bees have been ruined because, after uniting, the apiarist did not go back a few minutes later to see if all was well.

There is another difficulty in uniting; and that is, that the old bees, if taken from the same yard, are quite apt to go back to the old stand. This is especially true if the uniting is performed during or immediately following a honey flow. Young bees that have never been out of the hive will stay where they are placed, and perhaps a majority of the old ones.

The old-fashioned black bees can be moved about from one part of the apiary to another with less trouble than the Italians because the blacks will find their location better. But when uniting by the newspaper plan (to be described further on) this point need not be considered.

If the several colonies to be united all

have queens, no attention need be paid to them if there is no choice among them. If one is better than the rest, cage her when uniting and kill the others. This is a precaution.

Uniting Out-Apiary Bees with Those of the Home Yard

In these days, when out-apiary bee-keeping is practiced on so large a scale, the weak colonies or nuclei of two separate yards can be united very easily without any returning. When one finds a number of undersized or weak colonies in two or more of his yards, he can put the weaklings of one yard with the undersized or medium-strength colonies of another, thus bringing them all up to normal strength either for honey-gathering in early summer or for wintering at the close of the season.

Newspaper Plan of Uniting

There is one way of uniting at any time in the summer or fall that is very safe, known as the newspaper plan, and it may be practiced even when the bees are flying to the fields. The moved hive with its bees is put on top of another with a single thickness of newspaper between. By the time the bees from above gnaw through some time elapses. There will be no fighting and most of the moved bees will stay. In very hot weather it is important to take a lead pencil and prick a hole through the paper the size of the pencil to prevent smothering.

Uniting Colonies in Pairs

It is a common custom to place hives in pairs. When hives are so placed a colony can be united to its neighbor by removing one hive and placing the other in a space midway between where the other two stood. There will be no going back of any bees because they are almost in the same spot they were. If the newspaper plan is used in connection it will make a sure and safe job.

Uniting New Swarms

This is so easily done that directions are hardly needed; in fact, if two swarms come out at the same time, they are almost sure to unite, and two such swarms are not likely to quarrel. Swarms will always stay where they are put. One of the queens will very soon be killed, but the extra one may be easily found by looking for the ball of bees that will be seen clinging about her very soon after the bees have been joined together.

While swarms can be united, it is not advisable to unite a swarm with an old colony without smoking them at first or at least waiting after uniting.

The safer and better way is to use a newspaper between the two stories as before explained; but when the newspaper is used on a hot or sultry day, be sure to poke a hole in it with a lead pencil to prevent suffocation.

This and the Alexander plan, described further on, are the two best ways of putting two families of bees together, and there will be little or no returning of the moved bees even from the same yard and no fighting.

Alexander Plan of Uniting

As has been pointed out under Spring Dwindling and also under Spring Management, uniting two weak colonies in the spring is usually unprofitable. Uniting a weak to a strong colony is quite a different thing. (See Requeening.)

During the year 1905, and again in 1906 and 1907, considerable interest was manifested through Gleanings in Bee Culture in the Alexander plan of uniting a weak colony to a strong one in the spring. Many of those who followed the method were very successful. A few, however, failed. To these latter reference will be made later. The Alexander plan of uniting as carefullly revised by Mr. Alexander himself is given:

Alexander Method of Building Up Weak Colonies in Early Spring

About six or seven days after taking the bees from their winter quarters, pick out and mark all weak colonies, also the strongest ones, selecting an equal number of each; then all weak colonies that have a patch of brood in one comb about as large as the hand. Set all such on top of a strong colony with a queen-excluder between, closing up all entrance to the weak colony except through the excluder.

Where there are any that are weak, only a queen and perhaps not more than a handful of bees with no brood, fix these in this way: Go to the strong colony you wish to set them over and get a frame of brood with its adhering bees, being sure not to take their queen; then put the queen of the weak colony on this comb with the strange bees, and put it into the weak hive; leave them in this way about half a day; then set them on top of the strong colony where you got the brood with a queen-excluder between. Do all this with very little smoke, and avoid exciting the strong colony in any way. If a cool day, and the bees are not flying, I usually leave the strong colony uncovered, except with the excluder, for a few hours before setting on the weak colony. The whole thing should be done as quietly as possible, so that neither colony hardly realizes that it has been touched. When the weak colony has been given some brood, and put on top in this careful and still manner, hardly one queen in a hundred will be lost, and in about 30 days each hive will be crowded with bees and maturing brood. Then when you wish to separate them,

set the strongest colony on a new stand and give it also some of the bees from the hive that is left on the old stand, as a few of the working force will return to the old location, especially if they are black bees or degenerate Italians.

In every case that has come to my notice where this method has been reported a failure it has been from one of two causes—either lack of brood in a weak colony to hold the queen and her bees in the upper hive, or smoking the strong colony so that, as soon as the weak one was set on top, the bees from below would rush up and sting every one above. Therefore avoid using smoke or doing anything to excite the strong colony.

Where one desires to proceed with extreme caution he is advised to put a wire-cloth screen between the two lots of bees at the time of uniting, keeping it there for two or three days, after which its place is taken by a perforated zinc honey-board. In this connection it should be said that the wire-cloth screen should be mounted in a wooden frame about ⅜ inch thick.

The Alexander Plan for Fall

While this plan of uniting contemplates performing the act in early spring, the same thing can be done in the fall. Mr. Josiah Johnson, in a communication to Gleanings in Bee Culture, tells how he unites by the Alexander plan in the fall:

Some have had trouble in following the Alexander plan of building up weak colonies. I think the trouble in many cases is due to rousing up the bees and getting them uneasy before the weak colony is put over the strong one. Then the two colonies have war for a while. I always use wire cloth between the two hives and never have any trouble from the lower colony going up and killing the bees in the upper hive. For some time I have wintered my weak colonies this way on the summer stands. Last winter I had several weak colonies, and I put them all over strong colonies, making an entrance in the back with my knife through the handhole of the upper hive. This should be just large enough to allow two or three bees to pass out at a time. This is done on some cloudy day after very cold weather comes.

Last year I had a weak colony of bees. There was just one frame of bees and a young queen. I put this frame of bees in with nine frames of honey, and put the frames in a hive and set it on top of one of the strongest colonies I had, and in February they got pretty strong, and I left them on till April; and when I set them off I had two strong colonies.

Milan, Ill. Josiah Johnson.

(See Building Up Colonies, Spring Dwindling, and Spring Management.)

V

VEILS.—When dealing with hybrids, Cyprians, Syrians, or Palestinian bees, a veil is a necessity. With Italians, Carniolans, or Caucasians it is not so important; still it is advisable to have one on the hat ready to pull down. Its use in any case gives the apiarist a sense of security that will enable him to work to much better advantage than he could if continually in fear of every cross bee that chanced to buzz near his eyes.

The two objections that have been made against the use of veils are that they obstruct the vision somewhat, and interfere with the free circulation of air in hot weather; but with a good veil these objections are not very serious. Our best beemen, as a rule, wear a veil constantly when among the bees, and it is best to do so.

The lightest veil is one made entirely of silk tulle. The material is so fine that a whole veil of it can be folded to go in a small vest-pocket. A cheaper one, though not so light, is made of cotton tulle with a facing of silk tulle sewed in. The cotton tulle is strong, and the silk tulle facing obstructs the vision but little if any.

The top of the veil is gathered with a rubber cord, so that it may be made to fit closely around the crown of the hat.

There is a special broad-brimmed cloth hat, costing about one dollar each, that is sold by dealers. These hats are very light, will fit any head, and can be folded and put in a coat-pocket. During hot days when bees require the most attention in the apiary, a coat or vest is simply intolerable. In the absence of either one of these garments the corners of the veil may be drawn under the suspenders. The views (bottom of previous page) show the manner of drawing the veil under the suspenders, and its position when in use. The last view of the series shows how easily it can be drawn out from under the suspenders and raised above the hat while not in use. A few apiarists work a large part of the time with the veil raised. When the suspender method of holding is used one can raise or lower and fasten the veil in a moment's time.

A Folding Hat and Veil

The veil shown above is made up of a folding wide brim hat with a steel rim to hold out the brim. The veil proper is of silk or cotton tulle, and, of course, can be folded up like a handkerchief with the hat and put in a side coat pocket. The rubber cord at the bottom front of the veil makes a snug fit against the chest so the bees can't crawl up.

Wire Cloth Veils

There are many practical beemen who prefer wire-cloth head-protectors to anything else. They are much more substantial and wear longer than the veils made of fabric only. When first used they seem a little awkward; but the extreme comfort that one enjoys more than compensates for their apparent stiffness. As they are made of black wire cloth they will not catch or tear on any obstruction. The skirt is made of muslin and should be drawn up snugly around the

Indestructible veil with wire cloth.

collar by means of a draw-string. The screen is shaped so that the shoulders will not push the veil off the head, and has a deep face which allows one to look down at the hive and still look through the netting instead of the view being obstructed by the cloth.

The Alexander veil, shown below, is used by some of the most extensive beekeepers in the country. It is a plain wire-cloth cylinder having a circular gathering of muslin at the top, and a sort of skirt of the same material sewn to the bottom edge. With this outfit one will be required to go bareheaded or wear a small cap. Much of the work of the apiary is done during the hottest weather, and this veil is very cool. Like the one just described, it does not get "hooked"

Alexander veil.

in passing among trees or shrubbery, nor does it get torn like some of the veils of fabric.

A Collapsible Wire Cloth Veil

One objection to the cylinder wire cloth veils just shown is that they can not be folded. This difficulty has been very nicely overcome by Mrs. Walter Leininger of Delphos, Ohio.

Collapsible wire-coth veil.

As will be noted it is made up of four wire cloth panels held together at the corners by a narrow strip of tape sewn into the wire cloth. The front panel is made large and the rear one small to give greater vision and better facility for moving the head back and forth. The two side panels are wedge shaped to better accommodate the large panel in front and the small one in the rear.

This veil can be folded up into a flat package that will go under an automobile seat or slipped under a hive cover in a bee yard where it will be ready for the next visit.

How to Get Along Without a Veil

Occasionally one meets a person who says he does not need any bee-veil and never uses any in his bee work. Such a person is to be pitied rather than admired for his temerity. He will often spend enough time smashing bees that sting him in the face to make up many times over for the slight inconvenience of the veil. It is foolhardy and totally unnecessary to run the risk of a bad sting around the eyes, nose, mouth, or ears, and a good beekeeper is wise enough to wear a veil of some sort or have one on his hat ready to pull down.

Occasionally there will be times when one will have to do some work with the bees without a veil. Perhaps it has been forgotten, or perhaps a visitor more susceptible to stings has to have it. In such cases as these one should make sure that his smoker is in excellent working order, with plenty of fuel. It should be held between the knees when not in use to be ready for instant service over the frames. If the day is at all chilly smoke should be blown down over the frames quite frequently. By proceeding very cautiously, using smoke every now and then, one can get along without a veil, but he wastes more time than if he uses one.

With gentle Italians on warm days one can have his veil thrown back over his hat; put he should always have it ready so he can draw it down instantly in case of emergency. This is especially necessary where one has to wear glasses. An angry bee will sometimes get between the lenses and the eyes, and the owner in order to save himself from a sting will sometimes break his glasses.

Bee Dress or Clothing for Beekeepers

Under the head of Gloves are described some long-sleeved gloves or gauntlets that reach up above the elbows. Many beekeepers use these to keep bees from getting up the sleeves, and at the same time to protect the wrists, especially the inside fleshy portions of them where they are very sensitive.

As for trousers, one can get a pair of union overalls at any clothing-store, and

White bee-suit.

it is suggested that he get outfits such as are used by machinists and engineers. These have numerous handy pockets, large and small, in which various tools may be placed.

One-piece overalls covering arms, waist, and legs are excellent. They can be slipped over the regular clothing or in hot weather can be worn without other garments than suitable underwear.

Bicycle pants-guards can be used to very good advantage during extracting

Miss Mary Culver, of Calexico, Calif., in her farmerette bee-suit. Her father is an extensive beekeeper.

and all other times when one is shaking or brushing bees off combs. The bottoms of the trousers should be neatly folded around the ankles, and the guards slipped on to hold the folds in place.

Bee-Suits for Women

In many parts of the West, as well as in some parts of the East, bee-women are wearing regular one-piece overalls gathered at the shoe top, or bloomers with puttees. Several of these styles are worn, and most of them are neat, safe, and sane. They are now getting to be quite common for general outdoor work. If desired, a full but short apron may be worn over the overalls, or a short skirt over the bloomers. High-top shoes or puttees will also add to one's feeling of security.

VENTILATION.—Bees that are outdoors in their regular hives generally receive at the entrance all the ventilation they require. There should be, except in very hot weather, no other openings. Occasionally hives are so poorly made that they will have gaping cracks, but these, unless too large, will be closed up with bee glue—usually along toward fall; and some strains of bees, notably the Caucasians, will close them up early in the season. Indeed, this race will sometimes restrict the entrance by means of little chunks of propolis.

In olden times it was customary for the patent-right men to furnish their patrons with hives having all kinds of ventilating holes and little trapdoors; but the modern hive has no openings of any sort except at the entrance, which is contracted or enlarged according to the season. In hot weather it should be opened to its maximum, and in cool weather it should be reduced to one-fourth, or even less, of its largest capacity. (See Entrances to Hives and Wintering.)

During extremely hot weather, and for strong colonies especially during swarming time, it is sometimes necessary to provide upward ventilation in addition to that provided at the entrance. The cover may be lifted up in such a way as to leave a crack at the back end. This will allow a current of air to circulate from the top clear down through the hive. But sometimes loosening the cover is insufficient. It is then necessary to provide ventilation for one or more supers that may be on the hive at the time. In that case, the second super is shoved forward on the lower one—just enough to leave a crack, front and rear. If that is not enough, the third super is staggered back so as to be in a vertical line over the bottom super; and in rare cases it may be necessary to go even further by tipping the cover up in addition. (See Swarming, subhead, Provide Abundant Ventilation.) It is much better to provide ventilation in this way, for extremely hot weather than to bore holes in the sides or ends of the hives or supers. The amount of ventilation that may be re-

quired through the top of the hive by staggering the supers back and forth will depend on how hot the weather may be at the time, and whether the hive in question is shielded from the sun. So long as the bees cluster out in front, it is an indication that there is lack of ventilation. Sometimes a great cluster of bees will be over a large entrance, practically closing it up except what little air can filter through the mass of bees. In cases like this it is advisable to lift the hive up on four blocks as shown under the subject of Swarming, subhead, Providing Abundant Ventilation. If this does not draw the bees into the hive, additional ventilation should be given at the top of the super or supers, in the manner already explained. But one should be careful not to overdo this, because comb-building can not progress very satisfactorily in supers when chilling blasts go down over the bees, and this is liable to occur at night, even after a hot day.

Ventilation During the Winter

Under Wintering, also under Entrances, it is explained that bees outdoors on their summer stands do not require nearly the amount of ventilation that is needed during the summer. Yet even in cold weather a strong colony should have a larger entrance than a weak one. (See Entrances to Hives.)

When bees are wintered in a cellar it is highly important that the atmosphere be dry, and that there be means provided for supplying fresh air in the room where the bees are kept. Insufficient ventilation causes uneasiness; uneasiness induces overeating, and overeating brings on dysentery. (See Dysentery.) It is important that the cellar have plenty of ventilation during the entire period of confinement, and more air toward spring than late in the fall.

Authorities disagree somewhat as to the size of entrance that bees require while in the cellar; but the author's experience indicates that the same size that is used during moderate summer weather is better than a large one. It will depend somewhat on the size of the colony. (See Wintering in Cellars.)

In severely cold weather it is highly important to see that the entrances of the hives outdoors are not closed up with wet snow nor ice. A dry snow does no harm. An entrance closed tight is almost sure to be fatal to the colony sooner or later if there is no upward ventilation. It sometimes happens that dead bees clog the entrance, and the colony dies simply because a few of its dead shut off its means of ventilation.

Smothering Bees by Closing the Entrance

Although bees manage to get along even with a very small entrance, one should be on guard against closing it entirely in warm weather, even for only a few minutes. Many are the reports the author has received of bees being destroyed by their entrances being closed while undertaking to stop swarming for a few minutes, until some other colony can receive attention. (See Swarming and Entrances.)

When bees have the swarming fever they are gorged with honey and in a feverish state. They are like a man who has been taking violent exercises after a hearty meal, and requires more than an ordinary amount of air. Their breathing-tubes are in different parts of the body, under the wings and on each side of the abdomen (see Anatomy of the Bee); hence, as soon as the entrance is closed, and they crowd about it, the heat of so many becomes suffocating in a very few minutes; the honey is involuntarily discharged, wetting themselves and their companions, thus most effectually closing their breathing-tubes in a way that causes death to ensue very quickly. Heavy swarms have been known to be killed in the short space of fifteen minutes, when the hive was thus closed. The heat generated by the smothering mass often becomes great enough to melt down the combs, enveloping bees, brood, honey, and all, in a mass almost scalding hot. Bees are sometimes smothered in this way, in extremely hot weather, even when the hives have very large openings covered with wire cloth. In fact, bees shipped by railroad, in July and August, have been known to be smothered when the whole top of the hive was covered with wire cloth.

How Bees Do Their Own Ventilating

If one will watch a colony of bees during a warm day, he will see rows of bees standing around the entrance, and far inside of the hive, with their heads pointing one way, all making their wings go in a peculiar manner, much as they do in flying; but instead of propelling their bodies along, they propel the air behind them, and a pretty strong "blow"

they get up too, as may be felt by holding the hand near them. If the air is very hot and close inside the hive, so that there is danger of the combs' melting down, they manage to send cooling currents clear to the farthest parts of the hive.

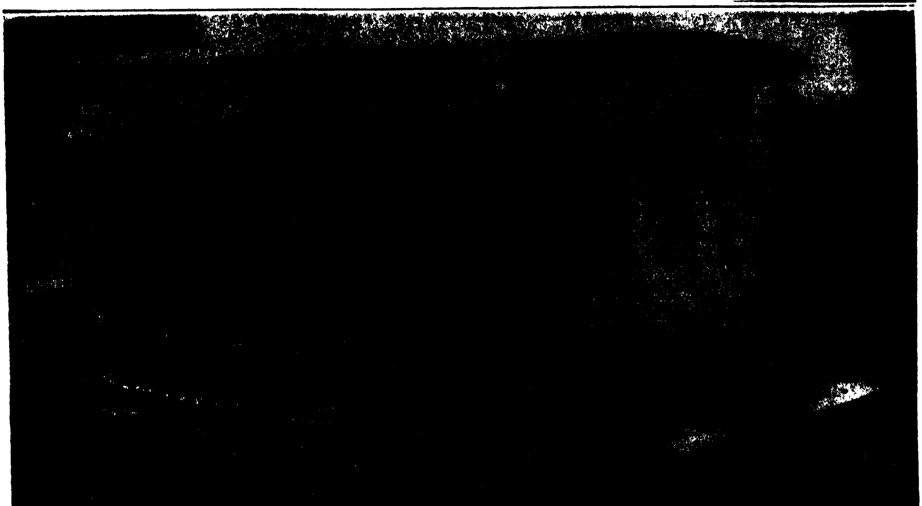
At the end of a hot day when the bees have been working heavily in the fields, it is very interesting to try the following experiment: Hold the smoker, with a little smoke issuing from the nozzle, near one side of the entrance and then at the other side. It will be noticed that there is a strong draft of air on one side of the entrance into the hive, and an equally strong blast of air on the other side of the entrance out of the hive. The direction of the air can be easily determined by observing whether the smoke is sucked in or blown out.

Sometimes the air will be sucked in on both sides of the entrance, and blown out from the center. At other times the reverse will be the case.

If one does not happen to have a smoker he can light a common match, when he will notice that the flame will be sucked in on one side and blown away on the other. The draft, whether out or in, is so strong that it will blow the match out.

The most prosperous colony the author ever owned was one that was so completely enveloped in chaff that during frosty nights in March they sent a stream of warm air out of their hive strong enough to melt the frost about one side of the entrance. Of course a stream of fresh air went in at the opposite side as fast as the warm air went out.

In the fall of 1916 there were a few hives located near some big lumber piles that were burned down. So intense was the heat that one of the hives took fire, with the result that it burned through on one side, and charred the boards under the metal cover; and yet, remarkable to relate, the bees were all right after the fire. It is presumed that some fireman, seeing the plight of the bees, threw on a pail of water; but how did the bees keep the combs from melting down in the meantime? There was no other way that they could do it than by their scheme of ventilation. Fortunate-



A hive of bees nearly burned up by the heat from an immense lumber yard fire close by author's plant. Somebody threw a pail of water over the hive and put the fire out. During all this heat the bees, by vigorously fanning with their wings, kept the hive ventilated so that the combs did not melt.

ly the entrance was large and wide open, so that they were able to ventilate the hive fully. The weather outside was cold. Now, combs sometimes melt down when the weather is very sultry and hot during the summer when the hives are out in the hot sun; but there is no cold air, as there was that night in front of the hive and away from the direct radiation of heat from the burning lumber. The photograph reproduced on page 739 shows that one side of the hive was burned clear through; yet, except for the outside comb, no damage was done either to the bees or to the combs.

For further particulars on the subject of ventilation, see Entrances, Comb Honey, Swarming, Wintering, and Bee Behavior.

VINEGAR.—This is one of the legitimate products of honey; and when properly made it is of excellent quality, fully as good as any other vinegar that can be made, if not better, from whatever source. The color and flavor of honey vinegar are largely dependent on the color and the flavor of the honey used. Obviously, a mixture of honey, or a number of odds and ends, as well as the washings, may be used to advantage. Thus honey vinegar makes a profitable by-product for a beekeeper.

How to Make Honey Vinegar

In the first place it should not be forgotten that vinegar may be made from any liquid containing sugar, provided there is enough sugar to be of any consequence. This includes a number of the fruit juices, of which the apple and grape are the best known examples, and syrups like honey or molasses.

Vinegar is the product of two absolutely distinct fermentations: first, the vinous, or alcoholic, and second, the acetic, or acid fermentation. The first should be completed before the second is begun; otherwise the first never will be completed and weak vinegar will result. This means, for instance, that the "mother of vinegar," the thing which starts the acetic fermentation, must not be introduced until practically all the sugar in the liquid has been converted to alcohol by the common wine or alcoholic fermentation.

The alcoholic fermentation will usually start spontaneously, but it is far better to insure its starting by the addition of a small quantity of yeast.

How to Make Honey Vinegar

Honey vinegar can be made just as cider vinegar is made by diluting the honey with water, then allowing the solution to ferment. Five parts of water to one part of honey by weight is about the right strength to make good vinegar. As the specific gravity of honey varies, it is perhaps well to check up the mixture of honey and water. When the liquid will just support a fresh egg, leaving a spot about as large as a dime above the surface, it is about right. Since such a dilute solution does not contain sufficient mineral matter for the growth of the organisms causing fermentation, it is well to add certain minerals. The Michigan Agricultural College has published a bulletin on honey vinegar in which the following formula is recommended: Extracted honey, 40 to 45 pounds; water, 30 gallons; potassium tartrate, 2 ounces; ammonium phosphate, 2 ounces. The bulletin recommends that this solution be boiled for ten minutes in order to kill all or most of the micro-organisms which would later cause trouble, and to give the vinegar a better color. The process of alcoholic fermentation can be greatly hastened by adding a starter prepared from a pure yeast culture. The acetic fermentation can be hastened by adding "mother of vinegar." The bulletin mentioned above tells how to make these starters.

The tank should not be of metal but of glass or wood. Common jugs are, of course, suitable. To make a quantity use a wooden tank, hogshead or barrel.

The process of fermentation in the first stage can be hastened by having the honey water trickle slowly over cypress shavings so as to expose the liquid to the air as much as possible.

If barrels are used the bung should be left out and the hole covered with cheesecloth. The barrel or barrels of liquid should be allowed to stand in a warm room and it may take some weeks before fermentation is completed unless cypress shavings are used.

It is only fair to say that unless one has a lot of cheap, off-grade honey that can not be sold at any price, one can not make a honey vinegar and compete with cider vinegar. Sweet cider from windfall apples is far cheaper than honey and water. While a honey vinegar when rightly

made is superior to cider vinegar, it is not possible to make the public think so when cider vinegar is cheaper.

VIRGIN QUEENS.—See Queens.

VITAMINS IN HONEY.—Whatever else we may say of the valuable accessory food elements in honey, we can not, with our present knowledge, make any very extensive claims as to the vitamins in honey. If present, there are only traces. If we need vitamins we better look to other foods where an abundance of them is found.

The work done so far is here recorded in order that others may be stimulated to go further.

The first worker in this field was Dutcher (1918), then of Minnesota and now of Pennsylvania State College, who studied nectar, honey, and corn pollen, and who concluded that the clover-basswood honey which he used contained negligible quantities of vitamin B, which may have its origin in suspended pollen grains. Pollen rather naturally contains vitamins. In 1919 Miss Bachman, of Wisconsin, used honey in a medium for the growth of certain yeasts which require vitamins for growth and found no evidence of vitamins. In 1920 Faber, of Stanford Medical College, examined honey for Vitamin C and found it lacking. Hawk and his associates in 1921 found little of vitamin A or B in extracted honey but found comb honey to contain vitamin A in moderate amounts, but no vitamin C. In 1922 Luttinger, of New York City, claimed to have found vitamins A, B, and C in 82 per cent of the honeys examined, and in the same article advised the use of honey in infant feeding. (No experimental evidence is given in this article.) In 1924 three German investigators, Scheunert, Schieblich, and Schawnebeck, examined three samples of honey and failed to detect the presence of vitamins. In 1926, Alan Callais, a well-known French beekeeping chemist, reported finding vitamin B in honey. The annual report of the Bureau of Home Economics for 1927 states that two samples of honey examined were found deficient in vitamins A, B, C, and D. Studies in Iowa by Nelson and Paddock are reported as finding that unheated white clover honey is found to contain very little vitamin A or B, but the comb appears to contain vitamin B. No studies for the presence of other vitamins appear to have been made so far.

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WASPS.—*Vespidae.* These would hardly have a place in a work of this kind except for the fact that, like bees, they sting; but, unlike bees, they can sting over and over again because their stings do not have barbs. In this group are yellow jackets and hornets, and the old phrase, "sting like hornets," carries a world of meaning to one who encounters one of their nests at close range. Whenever wasps, yellow jackets, or hornets are mentioned, there is a feeling of wholesome respect—keep away or suffer the consequences. As a matter of fact, they are no more vicious than honeybees. By the intelligent use of a modern beesmoker, they can be handled like bees. If anything, they are more easily handled.

The author, on his various lecture tours for the Redpath Chautauquas, has been repeatedly challenged to take down their nests before crowds. In every case there has been no difficulty whatever. All that is necessary is to approach their nests cautiously and gently blow a few puffs of smoke into the entrance. Keep on puffing until all the wasps are out of the nest. The air will be full of the stingers, but not one of them will offer to sting. In the meantime the nest can be taken down and picked to pieces before an astonished crowd and no one is stung.

Bumblebees can be handled in the same way. (See Bumblebees.)

All this points to a common ancestry for honeybees, wasps, yellow jackets,

and hornets. Their stings are a means of offense and defense, and the same means that will control one class of stingers will control the others.

WATER FOR BEES.—At some seasons of the year there is not enough moisture in the hive for the use of the colony. At these times worker bees carry water to the hive for immediate use. Water is not stored in cells as is nectar, but may be placed on top-bars or in other places under some conditions. The gathering of water is more noticeable in the period of early spring brood-rearing and in hot weather than at other times. In certain bee-cellars of quite high temperatures it is recorded that an uneasiness of the bees has been relieved by giving water in feeders at the entrances of the hives.

Some time ago G. S. Demuth made an interesting observation in the apiary of the Bureau of Entomology. By mistake an entrance-reducing block had been pushed into the hive and was not noticed when the time came for these blocks to be removed. It closed the entrance too much during the hot weather of midsummer, so that the normal ventilation of the colony was impeded and evidently the temperature within the hive became too high. When this colony was opened on a hot day in midsummer, it was noted that drops of some liquid were deposited on the frames, much in the manner of nectar when it is being brought to the hive during the rush of an exceedingly heavy honey flow. There was at this time a complete dearth of nectar. In tasting this liquid, it was found to be water, evidently brought to the hive to be evaporated and thus to reduce the temperature within the hive, since evaporation of water causes the absorption of considerable amounts of heat.

Bees Gather Least Amount of Water During Honey Flow

In an interesting paper published by DeLayens, the well-known French botanist and beekeeper, in the "Bulletin d'acclim. de France" for 1880, page 298, he shows that, while considerable amounts of water are taken from a water reservoir in the apiary before the honey flow begins, this collection entirely ceases when nectar comes to the hive in considerable amounts. For example, on May 22, a total of three liters of water was taken from the reservoir, while on the next day this was reduced to one liter, and steadily decreased until May 27, when the honey flow was well on and no water was taken from the reservoir by the bees. In another series of observations he correlates the collection of water with the weight of honey gathered by the bees and finds a definite and close inverse correlation. For example, on July 15 the bees in his apiary took five liters of water from his reservoir, while a strong colony in the apiary gained only 120 grams. There was a steady decrease in the amount of water taken and an equally steady increase in the nectar collected, until on July 19 no water was taken from the reservoir while the strong colony gathered 1.390 kg.

Another series of interesting observations are recorded by Gendot in "L'Apiculteur" for 1907, page 164. He noticed, as have many beekeepers, that bees collect water from compost heaps. To determine whether they are attracted by the character of the material which they may there collect or whether some other factor is involved, he made certain tests. He found that the standing water about the compost had a higher temperature than that of the surrounding air. He then set out in his apiary two reservoirs containing pure water, one at air temperature and the other somewhat heated. During the month of April the bees collected over 43 liters of water from the reservoir that was heated and only a little over 7 liters from that which was not heated. He made proper allowances for extra evaporation of the heated water in that reservoir. Later on, when the outer air became warmer, the bees visited one reservoir as much as the other. He also found that it takes a much longer time for a bee to take a load of cold water than of water that is somewhat heated. Several observations are quoted regarding the amount of water per colony that is taken by the bees, and Gendot states that, after heating the water, his colonies took an average of almost a half liter daily, most such observations being of smaller amounts per colony. Evidently bees will take enormous quantities of water in spring if it is conveniently placed, and it is safe to assume that they do not take it unless they need it.

Elimination of Water in Summer

At times of a heavy honey flow large

quantities of water arising from the evaporation of the excess water in nectar must be eliminated. Various analyses of nectar show that the water content varies greatly, and this is easily observed by any beekeeper. Some unripe honeys, or partly ripened nectar, are exceedingly thin, while in some cases nectar is brought to the hive in a condition of thickness which resembles honey. In general, thick nectars are found in arid regions or in periods of warm weather, as one might expect, while thin nectars are found during early honey flows in spring. Nectars from some species of plants are almost always thin, while that from other species is usually thick. (See Nectar.)

This elimination of water from nectar not only influences the humidity within the hive but causes a large amount of work for the bees. The work which the bees are called upon to do varies greatly according to the outer temperature, since in cool weather the relative humidity of the outer air is usually higher, making evaporation more difficult, and furthermore the temperature of the hive must then be kept relatively higher than that of the outer air. Some nectars have a water content as high as 80 per cent. If this is the case, to obtain 100 pounds of honey, which would contain about 20 pounds of water in the final product, the original nectar would weigh 400 pounds, which would consist of 80 pounds of sugar and 320 pounds of water. Of this vast amount of water, 300 pounds must be eliminated before the honey is ripe, or three times the weight of the resulting honey.

To transform water into water vapor requires a large amount of heat, namely, 535.9 small calories per gram of water, or enough to raise the temperature of the gram of water 535.9 degrees Centigrade. To evaporate the 300 pounds of water mentioned above would then require 72,923.664 large calories. On the assumption that the sole source of these heat calories is the food of the bees, it would require the consumption of over 49 pounds of honey to evaporate this water. It is evident that the bees must under some circumstances consume large amounts of honey to obtain the energy necessary for the evaporation of the excess water in nectar. This in turn causes the necessity for gathering more nectar to take the place of the honey consumed in this process. If it were not true that the external heat assists the bees greatly in this elimination of water, the honey crop would in some cases be greatly reduced.

The Evaporation of the Nectar

The evaporation of the surplus water in nectar is one of the most interesting things in the hive behavior of the bees. There are still many undetermined points regarding this course of behavior, but generally the returning field bee does little toward this ripening, but deposits its load in the first convenient place. This may be in the mouth of a young hive bee, in a cell of the brood-nest, even one containing an egg or a young larva, or even on the bottom-bar of a brood-frame. From this point on, the ripening process probably depends on the work of the younger hive bees. They move it from place to place, often with no apparent purpose, but the outcome of their work is that the thin nectar is placed in cells so as to expose as much surface as possible, thus aiding evaporation. Evaporation is also increased in proportion to the movement of air over the exposed surface of the liquid, and the bees fan currents of air through the hive, even though it may be several stories high, and thus hasten evaporation. How this fanning becomes regular, in on one side and out on the other side of the entrance, is still one of the mysteries of bee life. Several investigators have studied the number of bees engaged in fanning at the entrance, and find that this number is in close relation to the amount of evaporation going on within the hive, so that it is evident that, in the marvelous division of labor within the colony, about the right number assume this task. (See Ventilation.)

Water Not Discharged from Nectar in Flight

It has been held that bees can and do discharge some of the excess water in nectar during flight. Some work done by O. W. Park of the Iowa State College of Agriculture goes to show that this is probably a mistake. (See Research Bulletin No. 151, April, 1923, Ames, Iowa.)

The Need of Water in Bee Cellars

At one time it was believed that too much moisture or water in a bee cellar was detrimental. Some later work would seem to indicate that it may be advan-

tageous to supply colonies in the cellar with pans of water at the entrances or under the clusters, especially if the bees are uneasy, or inclined to fly out and die on the cellar floor.

Absorption of Water by Honey

Honey has the power to take up moisture from a saturated atmosphere or one in which the relative humidity is high, while in an atmosphere of low relative humidity it gives off some of its moisture and becomes thicker. Various efforts have been made to continue evaporation after honey is extracted, and this practice seems to be common in some parts of the world. The practice of storing honey in large tanks in California probably is beneficial in this respect. A recent paper by Waters, of the Wellington, New Zealand, Biology Laboratory, is of interest in this connection. He exposed honeys of various specific gravities to atmospheres of various relative humidities and noted the change in the specific gravity of the honeys. He finds that heavy honeys give off little moisture in dry atmospheres but attract relatively more moisture from a saturated atmosphere, while thin honeys part with moisture in a dry atmosphere but attract less moisture in a saturated atmosphere. The samples used attracted moisture from the saturated atmosphere much more quickly than they parted with it in a dry atmosphere, which indicates the necessity for great care in the exposure of honeys to the air after extracting. Fermentation of honeys, perhaps a year after extracting, is far more common than is usually supposed. Part of this may be due to the extracting of unripe honeys, but in all probability the greatest cause of this loss is the failure properly to protect the honey from excessive relative humidity while stored. (See Honey, Spoilage of.)

The attraction of moisture from the atmosphere is more commonly observed in comb honey than in extracted honey, because the honey is readily diluted by absorption of moisture from the air, in spite of the wax capping. There is a common belief among beekeepers that honey thinned by the absorption of water from saturated air is one of the causes of the condition known as dysentery. There is no reliable evidence that this is the case, and the probable explanation of the prevalence of dysentery in cellars where the combs are damp and mouldy is that under such conditions the bees must generate much heat and must therefore consume more honey than in a good dry cellar of higher temperature.

These explanations of the source of the water vapor within the hive and the discussion of the laws which govern its elimination as vapor serve to show how intimately the behavior and welfare of the colony are connected with this problem and show conclusively that there is great need of further investigations on this subject. It will require the devising of special scientific apparatus and the taking of records over considerable periods of time, for without long observations the records will be of almost no value but will merely complicate an already confused subject. It is clear from what has been said that enormous quantities of water must be given off from the colony at all seasons of the year, chiefly of course during the period when nectar is being ripened. That this may leave the hive in the form of water vapor, it must be carried out in an atmosphere which at all times is kept warm enough so that condensation may not occur. During the colder seasons of the year this requires heavy insulation.

The elimination of water from the hive in winter, the gathering of water for the regulation of temperature, and the evaporation of water from nectar are examples of the necessity for a study of the physical conditions within the hive. All of these phenomena follow well-known physical laws, and the solution of many of the problems in beekeeping rests on a proper understanding of such laws.

WAX.—This is a term that is applied to a large class of substances very much resembling one another in external characteristics, but quite unlike chemically, The wax of commerce may be divided into four general groups: Beeswax, familiar to all; mineral wax, or by-products from petroleum; wax from plants, and wax from insects other than bees. The first two are by far the most important commercially in this country. Of the mineral waxes the most common are paraffin and ceresin. Beeswax, the most valuable of all the waxes, has a specific gravity of between .960 and .972, and a melting-point of between 143 and 145 degrees F. The mineral waxes vary so much

in hardness, melting point, and specific gravity that it would be useless to name exact figures. As a rule, however, the fusing point of paraffin is much below that of beeswax, while that of ceresin may be either above or below, or practically the same. For its ductility beeswax has the highest melting point of any wax known. In general the specific gravity of both commercial paraffin and ceresin is below that of beeswax; which fact renders it an easy matter to detect adulteration. Alcohol and water are mixed to a point where pure beeswax will just float. If the suspected sample rises higher in the liquid its purity is questioned.

There are also known to commerce Japanese wax and China wax and carnauba, the last being of plant origin.

The Annual Production of Beeswax

In *pounds*, the amount of beeswax produced in the United States, compared to the honey, may not be over two or three per cent. In *dollars*, the proportion is greater. It is probably conservative to say that the annual production of beeswax is worth from seven and a half to ten per cent as much as the honey. At present prices the total value of the beeswax produced in United States annually is probably around a million dollars.

While the manufacture of comb foundation takes relatively only a small proportion of the beeswax produced, it is interesting to note that the comb honey producer is essentially a user of beeswax, while the extracted honey producer is essentially a producer of beeswax.

Comb Foundation

Combs made from foundation containing 25 to 50 per cent of adulteration of paraffin or ceresin are very liable to melt down in the hive in hot weather. Paraffin is ductile enough to make beautiful foundation, but does not stand the heat of the hive. Ceresin, on the other hand, while more closely resembling genuine beeswax in point of specific gravity and fusibility, is too tough and brittle, under some conditions, for bees to work. Work it? Yes, they will, and construct combs; and in Germany considerable ceresin foundation has been sold; but experience shows that it is poor economy, and that it will lead the beekeeper or the poor bees to grief sooner or later.

Some recent work shows that vegetable waxes can be used to strengthen ordinary beeswax from the hive. In 1922 there was introduced a three-ply comb foundation, the center ply of which is beeswax toughened with a small percentage of vegetable wax. The tests of this foundation show that it is much stronger and better than ordinary foundation for the broodnest. (See Comb Foundation, subhead Three-ply Foundation.)

Beeswax in the Arts

Since the United States pure-food law went into effect, June 30, 1906, beeswax has had a much larger use. The law will have no effect one way or the other on the use of paraffin, ceresin, and the like in any compound or mixture that does not belong either to the food or drug classes. Electrotypers can use a substitute for taking impressions. Natural-wood finishers can still use paraffin and ceresin; but most of them assert that there is nothing to compare for that purpose with pure beeswax. Paraffin gives a greasy, smeary finish, while the product from the hive yields a highly polished surface —one that stands wear as nothing else will.

A very satisfactory floor finish can be made by melting a pound of beeswax, and, while it is cooling, stirring into it some turpentine. An exact proportion of the two ingredients is not necessary—in fact, some workmen prefer the paste thick, others want it thin. When cool, if the mixture is too thick it is a simple matter to thin it by working in more turpentine. A harder finish can be secured by adding a little carnauba wax—about 25 per cent.

The Roman Catholic Church uses large quantities of wax in candles. This will be referred to further under Wax Candles.

Certain grades of blacking, harness oils, and lubricants require pure beeswax in their manufacture. A blacking containing beeswax will withstand more dampness than that made of any other substance.

There is very good evidence to show that beeswax is still the best insulating wax for coils and that the manufacturers of coils and other appliances are not using substitutes as much as they once anticipated, yet beeswax has many competitors in the shape of various vegetable waxes and resins, and more recently in synthetic waxes obtained by hydrogenizing certain heavy vegetable oils.

One of the frequently expressed objections to beeswax on the part of large users, such as manufacturers of electrical appliances, dental wax, cosmetics, polishes, etc., is that it varies so much. Most natural products do vary but it is a fact that beeswax varies more than it should. There is a difference between beeswax melted from new combs or from cappings and beeswax melted from old combs. The former is freer from propolis and therefore it has a lighter color, a more pleasing aroma and a higher melting point.

In all the arts, paraffin, ceresin, and certain other mineral waxes can be used; but none of them have all the desirable qualities furnished by the product from the hive.

How the Bees "Make" Wax

If the bees are watched closely during the height of the honey harvest, or if at other times a colony of bees is fed heavily on sugar syrup for three days during warm weather, there will be found toward the end of the second or third day little pearly discs of wax, somewhat resembling fish scales, protruding from between the rings of the under side of the body of the bee. (See cut page 415.) These, when examined with a magnifier, prove to be little wax scales of rare beauty. Sometimes these scales come so fast that they fall on the bottom-board and may be scraped up in considerable quantities, seeming for some reason not to have been wanted. During the season for natural secretion of wax where a colony has plenty of room, wax scales are seldom wasted in this way. At swarming time there seem to be an unusual number of bees provided with wax scales, for when the bees remain clustered on a limb for only a few minutes bits of wax are attached as if they were going to start combs. (See page 416.)

The way the bees remove these wax scales from their bodies and construct them into comb is not so easily seen. There were many wild guesses as to how this was done. The so-called "wax-pinchers"* on the hind legs were supposed to play an important part. The matter was definitely cleared up by Sladen and Casteel. In circular No. 161, Dr. D. B. Casteel, of the Bureau of Entomology, Washington, D. C., made the process plain.

*The real purpose of these is explained under Pollen, subhead, Behavior of Bees in Collecting Pollen.

Briefly stated, it is this: The wax scales are scraped off by one of the large joints, or plantae of one hind leg, the spines of the planta piercing or catching into the scale; then the leg, by a peculiar maneuvering, is moved up to where the fore legs may grasp the scale. At this point of proceedings the scale is manipulated or masticated in the mandibles, when it is applied to the comb. During the process the bee stands on three legs (the two middle legs on either side, and one hind leg not in action), while the other hind leg and the two fore legs, in connection with the mandibles, perform the manipulation. Casteel says that the so-called "wax-pinchers" in the hind legs have nothing to do with the manipulation of wax, but are designed for another purpose, and that each individual bee removes its own wax scales.

It has been supposed that the bees remove the scales from each other; but Casteel shows that this is not the case. The scales are sometimes found scattered throughout the hive and on the bottom-board as already stated. In some instances they show the marks of the spines of the planta of the hind legs. In others they were probably dropped accidentally by the bees in that wonderful sleight-of-hand performance by which they transfer the scale from one portion of the body to the other. In still other cases the scales show no markings whatever, and the presumption is that they simply fell off the bees when they reached a certain stage of development.

Dr. Casteel also confirms the observation of Dreyling, that there are certain ages and certain seasons when the bees will develop these wax scales more than at others. From this it would appear that there are times when the bees can not construct combs to any great extent, even though they are liberally fed. In a practical way it has been found that sometimes even when the bees are fed they will not build combs; and the probabilities are that they simply can not, because the colony is made up of bees too young, too old, or both. Usually the condition of a honey flow can be supplied artificially by feeding.

Amount of Honey Used in Making a Pound of Wax

The old estimate was 20 pounds of honey to make a pound of wax. Later

work has shown that the amount does not much exceed six or seven pounds. When the bees can fly every day, gathering nectar and pollen, the amount is probably less, although it is difficult to measure it, for the amount of honey the bees actually consume can not well be calculated.

Wax-Rendering

There are two methods of rendering wax, one by the use of artificial heat and the other by the use of the sun's rays through a glass sash on the principle of a hotbed. When these rays pass into a glass-covered box a considerable amount of heat is generated — enough to melt wax. The application of the solar method is quite simple and is here described.

Solar Wax-Extractor

It consists of an oblong shallow box having in the bottom a black iron pan or pans,

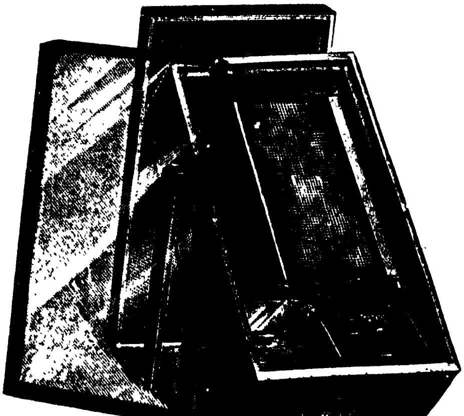


Fig. 1.—Doolittle solar wax-extractor.

and on top a double-glass sash. To get the best results, the outfit is tilted at an angle and faces the sun.

Solar wax-extractors have their use to handle new combs, particles of fresh wax, pieces of burr-combs, and the like, and can be used to clarify and bleach to a certain extent wax already caked, but they are not adapted to the handling of old black combs that have several generations of cocoons in them. Large sun extractors will get the bulk of the wax out of such combs, but they do not get all of it. If sun heat is used at all for melting, the refuse should be further treated.

Rendering Wax from Old Combs

For new combs the problem of rendering wax is a comparatively simple one, since the operation consists simply in melting them in hot water and dipping the wax off the top. When old comb is to be rendered, the problem becomes much more difficult, as the many layers of cocoons found in the cells used for brood-rearing confine the wax and make it hard to remove. If old comb is simply melted in hot water or steam, these cocoons will become saturated with wax, making the loss very great. The following discussion, therefore, will have to do especially with the difficulties encountered in rendering wax from old combs.

There are many different methods practiced by beekeepers to obtain the wax from old brood-combs; and it is needless to say that, in many of them, the loss is considerable. One of the crudest methods is to throw the combs into a large iron kettle of water and then build a fire and boil the contents for several hours, skimming the wax off the top of the water meanwhile. More comb is added from time to time, and the process is continued perhaps all day. Finally a piece of wire screen is weighted down on the refuse to keep it out of the way and facilitate dipping the wax. Careful experiments have shown that this method wastes from 25 to 40 per cent of the total amount of wax, while much time is required to clean and refine the wax that is secured.

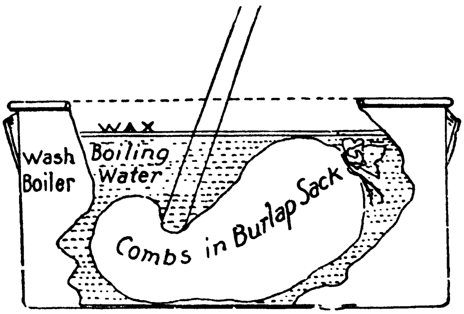


Fig. 2.—A very crude and wasteful method of rendering.

Another plan which has been advocated to some extent is that shown in Fig. 2. A sack of comb is held under the surface of the water, and agitated or punched with a stick for a long time until much of the wax is released and floats to the surface, where it may be dipped off. This method results in somewhat cleaner wax; but there is apt to be waste nearly equal to that in the plan before mentioned.

There is another method that is used more, perhaps, than the two which have just been described. It is a somewhat better plan, for the amount of waste is not so great. It is shown in Fig. 3. In order to get the best results the weights

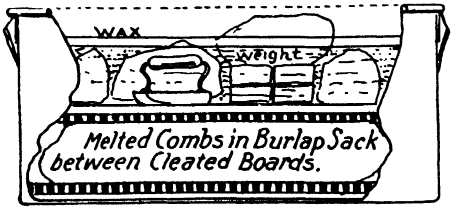


Fig. 3.—A popular but wasteful and slow method of obtaining wax.

should be so arranged that they can be lifted up a few inches in order to give the refuse in the sack a chance to become saturated again with hot water. The weights should then be put back, and this process kept up for several hours, the water meanwhile boiling vigorously. The wax should be dipped off almost as fast as it rises to the surface.

In 1904, T. J. Pennick, of Williston, Tenn., suggested the use of centrifugal force applied to hot slumgum just taken out of boiling water. It was his opinion that the free wax, when hot, would by this means readily separate from the solid matter in a very short time. Extensive experiments have shown that there would be a great deal of wax which would not escape from the refuse, no matter how fast it might be whirled in an extractor, showing that even great centrifugal force could not separate the wax from the refuse. Wax nearest the outside might be thrown out; but that nearest the center would be held back and not escape.

The Wax Press

It is doubtful whether anything but pressure combined with hot water can remove all of the wax. There will probably never be a wax-extractor of any kind that will economically remove the last particle of wax; but if the waste can be reduced to less than one per cent, the loss is negligible.

Before entering the discussion of wax-presses it may be well to add a word of caution to beekeepers who are sure that the particular method they are using enables them to obtain all the wax, or practically all. If the refuse, when the wax is finished, has not been put through a well-constructed press there will be no way of determining the amount of waste, for it might contain as much as 20 per cent of wax and still look perfectly clean and show no traces of it when examined. On a small scale it is possible to get some idea of the amount of wax left in refuse by the following very simple plan:

Thoroughly heat in boiling water the refuse to be tested, then allow it to cool partially; seize a large handful, and squeeze it as hard as possible in the fingers. If fine lines of wax appear in the creases between the fingers considerable wax is left—perhaps from five to

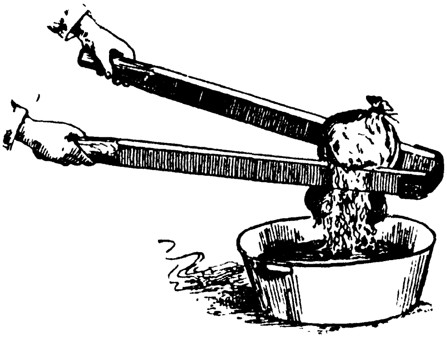


Fig. 4.—An unhandy and unsatisfactory plan.

ten per cent or more, depending upon the amount of wax shown. The hand will not be burned in the very short time necessary to make this test. But, as before stated, the most conclusive method of determining the waste is to run the refuse through a well-constructed press.

Hot-Water Wax-Presses

In hot-water presses the pressure may be continued without the least danger of chilling the combs. The hot water has the decided advantage that the screw can be raised after having been turned down, when the "cheese" can become saturated again with boiling water. The screw may then be lowered, and the hot water forced out of the refuse, carrying with it more of the wax. This operation must be repeated as often as found necessary by experience. It is thus seen that there is no disagreeable handling of the refuse until all the wax is out. Furthermore, the work, if necessary, may be confined to the one tank.

Orel L. Hershiser, of Buffalo, N. Y., devised the hot-water press shown in Fig. 5. The capacity of this is large, so

that it is possible to obtain as much as 75 pounds of wax in one day over a common stove.

The quality of wax from a strict hot-water press is usually not very good, because of the long-continued high temperature. In the Hershiser press more hot water is introduced at short intervals into the lower part, causing the melted wax to overflow through the outlet at the top. In this way the wax is not left for any

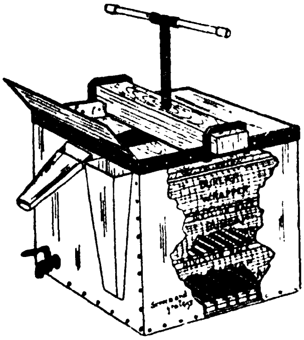


Fig. 5.—Hershiser hot-water wax-press.

great length of time on the boiling water, so that the color is not darkened.

Perhaps one objection to hot-water presses like the one here shown is its limited capacity and the cost of the outfit.

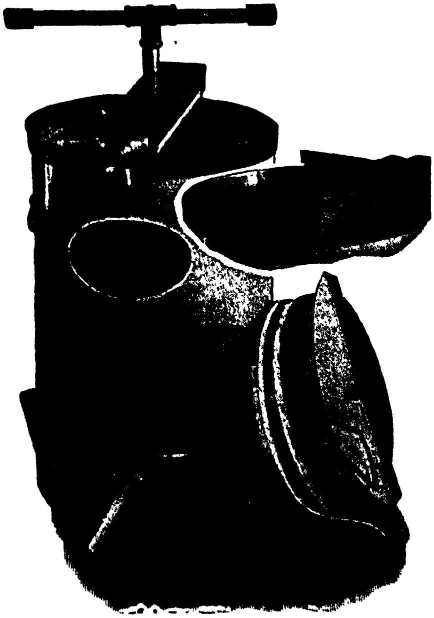


Fig. 6.—German steam wax-press.

Cleaner work can be done by an intermittent than by continuous steady pressure, and so it is well to relieve the pressure about every ten minutes, allowing the "cheese" two or three minutes in which to become thoroughly saturated again with boiling water. Pressure should be applied slowly at first in order to avoid bursting the burlap.

A steam-press of popular design is shown in Fig. 6. Steam is generated under a false bottom in the lower part, and, passing upward around the false bottom, surrounds the combs beneath the plunger in the perforated metal basket. As the wax falling from the refuse can not get into the water on account of the false bottom, it passes out of the tube shown.

A combination of steam and hot water will do cleaner and faster work than either steam or hot water alone.

Steam and Hot Water Press

The particular form of press that is sold largely is shown in Fig. 7. It will be noticed that a round can, constructed of tin, is used instead of the square wooden box and tray. The purpose of the cleats vertical and horizontal is to allow the free wax to escape from the cheese.

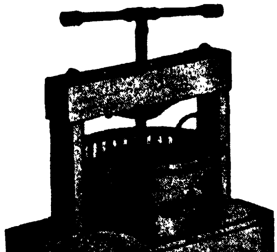


Fig. 7.—The Root single wax-press.

The Water Kept Hot by Steam

If no heat is applied to the combs during the pressing it is necessary to do the work in warm weather or in some room that can be kept hot by the heat of the stove used for melting, for when the air is cold the wax chills and the work is hindered. The efficiency of the press is greatly increased if a very small jet of steam is introduced from a steam-knife, boiler or teakettle, carried by means of a rubber tube to a one-quarter inch copper pipe about fourteen inches long, with

a right-angle bend five or six inches from the bottom and with a long curve at the upper end. This is applied to the wax-press can as shown in Fig. 8. As will be noted, the pipe goes down between two of the vertical cleats on the side of the can and is then extended over toward the center between two of the horizontal cleats at the bottom, under the screen. While the pressure is being applied the water and wax keep up a gentle boiling —an ideal condition. No matter how long the pressure is kept on the slumgum, nor how many times the screw is raised to allow the hot water to saturate the refuse again, the water is kept hot by the jet of steam and the wax on top shows no tendency to cool.

It was formerly recommended to run the refuse through the press a second time; but if steam is introduced as explained, the second melting and rendering is unnecessary unless the work has been very carelessly done. If there is any doubt as to the thoroughness of the work, it is a good plan to run the refuse through a second time to make sure that it is clean. The second rendering takes about half the time the first did.

An Ideal Equipment

Figs. 9 and 10 show the small outfit which the author recommends, including stoves, press, cans for melting the combs, boiler for steam, etc. A cook-stove with a top large enough to hold two good-sized wash-boilers is ideal, but frequently it is inconvenient to provide such a stove in a basement or outbuilding where the wax-rendering is done. Two double-burner gasoline stoves, one for each wash-boiler, will do as well. Oil stoves would answer the purpose for melting the combs, but are not quite so convenient, owing to the difficulty in turning down the oil burner in case the combs get to boiling too hard. Wash-boilers can not be cleaned very easily after being used for melting combs, hence should be kept for this purpose only. Many prefer to use a large square tank of galvanized iron, possibly over a brick furnace out-of-doors. Or a stock-feed cooker may be used, costing from $15 to $35.00.

The press should stand on a solid box that is firmly secured to the floor, and it should be hinged in front so that it may be tipped over to run the hot water and wax into the can beneath. A large box or basket must be provided to hold

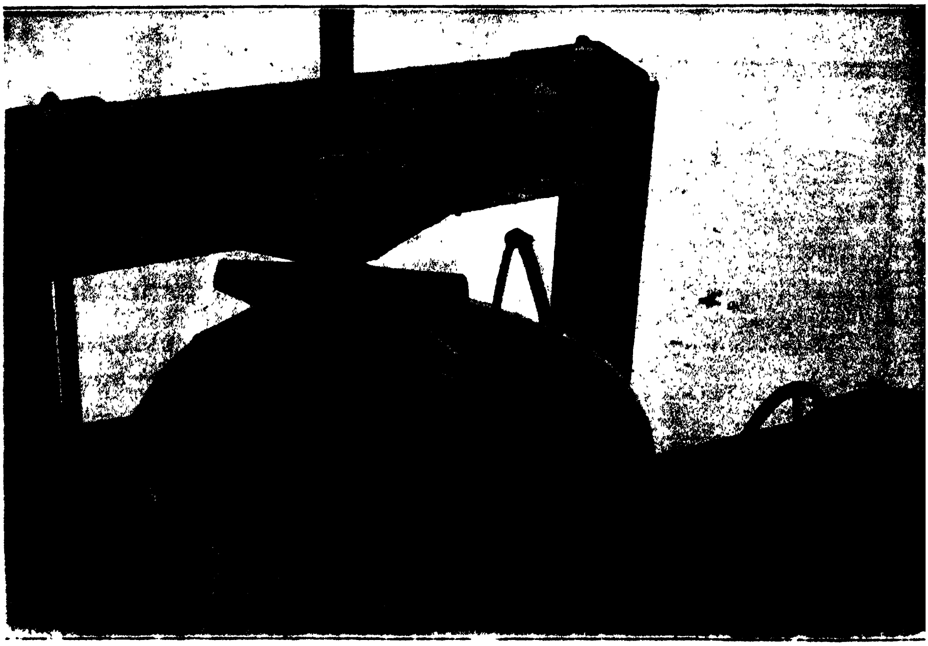


Fig. 8.—Steam from a small boiler introduced between the slats in wax-press can. The water and wax keep up a continual slow boiling, insuring constant circulation.

the refuse after it is pressed. An open-headed barrel with a plug at the bottom is the handiest receptacle for holding the hot water and wax.

Directions for Rendering

When ready to begin work light one of the stoves and put on a boiler a little over half full of water. If the water is very hard add a little vinegar to acidify the water and prevent partial saponification, resulting in mushy wax. When the water boils throw in the old combs. Thirty-five to forty combs (about half a barrel) may be put in gradually, provided they are carefully pushed down with a paddle and stirred as they melt. When all the comb that the boiler will hold conveniently has been put in, place the cover on and allow the mass to cook thoroughly. About this time light the other stove and put on another boiler of water; also set going the burner under the steam-boiler on a third stove to supply steam to the press-can.

It facilitates the work if a quantity of straw, preferably rye straw, is cut up in two-inch lengths and stirred into the melted combs. It makes the "cheeses" more porous so that less wax is left in the slumgum.

It is a mistake to begin pressing as soon as the comb is melted. Continue the cooking process with frequent stirrings until the combs are reduced to a steaming mushy mass. There must be no hard chunks.

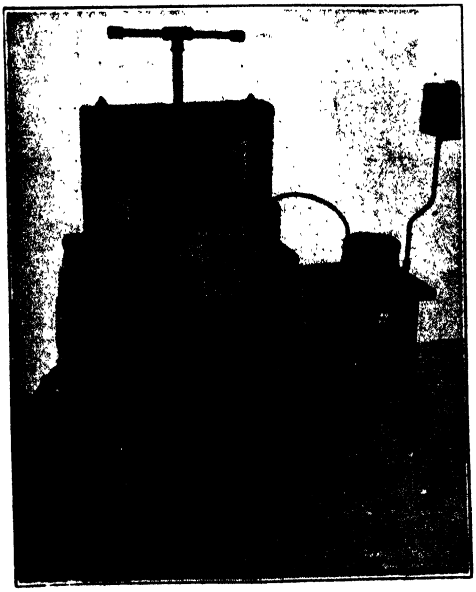


Fig. 9.—The press-can is pulled forward ready for filling.

When the contents of the first boiler are ready for pressing and the steam

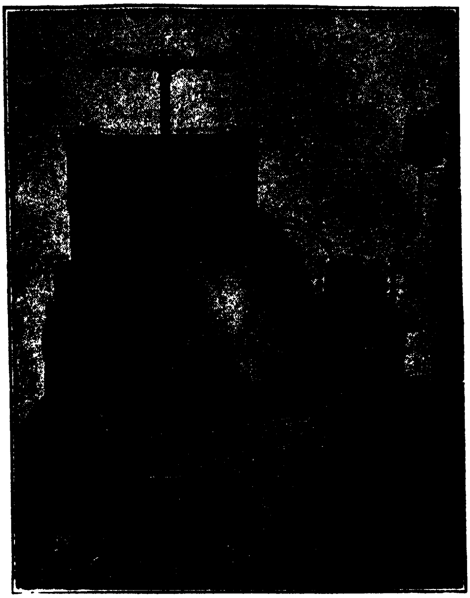


Fig. 10.—A large piece of stout burlap is the best material to use for holding melted comb.

begins to issue from the pipe in the bottom of the press-can, pull the can forward on the platform, holding it in position by means of the spider on the lower end of the screw resting on the top of the can as in Fig. 9. There should be in readiness a few pieces of good strong burlap, at least 40 inches square. Place one of these in the press-can; put the follower on top of it and throw a few dipperfuls of hot water from the other boiler into the can to heat thoroughly all the parts. Pour this off and spread the burlap down into the can as in Fig. 10. Dip about two gallons of the melted comb and water into the press and fold the burlap neatly over it, as carefully as though tying up a package. This is very important; for if there are thick rolls of the cloth in any one part of the "cheese," other parts of the refuse will not receive as much pressure as needed. To fold the burlap over, fold the back edge over toward the front, being careful to get the sides straight, then push the front edge over on top of it; lastly,

fold in the sides neatly. Place the cleated circular follower in position (cleats down, of course); push the can back exactly to the center of the platform and

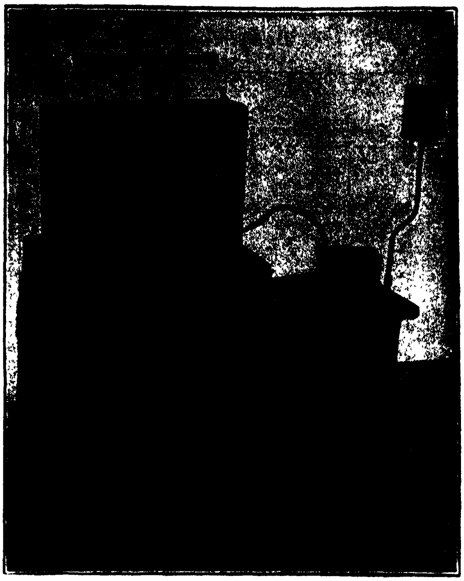


Fig. 11.—Apply the pressure.. The wax rises to the top of the water. As much time may be given to the pressing as desired—no danger of chilling, because of the jet of steam.

run the screw down very slowly—Fig. 11.

At this time it may be necessary to turn down the gasoline burners under the first boiler in order that the contents may not get too hot; or, if it is on a stove, pull it over to the edge. Use the utmost care to prevent the wax from slopping over. If it does, there is danger of having a serious fire. As soon as the water in the second boiler boils, begin filling that with combs.

Always turn the screw down slowly. If it is run down rapidly before the liquid in the mass inside the burlap has time to squeeze out, the burlap and the contents inside are likely to push up around the follower, interfering seriously with the escape of the water and wax. Turn the screw only when it turns easily. Of course, when it is clear down it may be turned tight; but there is really more danger in applying too much pressure than in not applying enough.

Sufficient water should have been dipped in with the comb so that the water and wax, when the screw is clear down, will just about submerge the iron spider on the end of the screw. It ought to take two or three minutes to get the screw clear down. When it is down about as far as it will go, release the pressure until the cast-iron follower is nearly out of the liquid; pull up on the rope handle of the wooden follower until it is free from the burlap, thus allowing the hot water to saturate the refuse again. After a minute or so apply the pressure slowly once more. This process should be repeated two or three times.

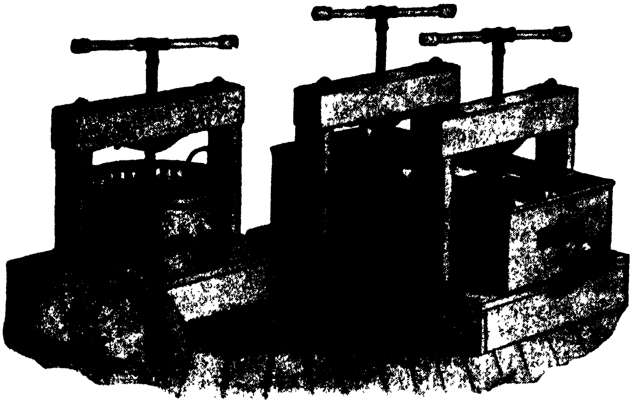
Instead of using a jet of steam as described, an extra can may be used, one to be on the stove being reheated while the other is under the press.

When the screw is finally down as far as it will go, place a washtub or a large can on the floor in front of the press and tip the latter over, pouring all the water and wax out. Leave the press tipped over a few moments until the wax drains out—Fig. 12.

When no more wax will drain out, tip the press back into its regular position and pour the hot water and wax into an empty can or barrel having a faucet at the bottom. If a barrel is used which is smaller at the top, the hot water must first be drawn off after the work is over, and the wax run into previously soaped molds to harden. It is more convenient

Fig. 12.—When the pressing process is completed the whole outfit is tipped up on its hinges to pour off the hot water and wax.

to use an oval-shaped can or round can that is larger at the top, so that the wax may be left right in it to harden in one large cake. There is no difficulty in lift-



The Root single and double wax-press.

ing the cake out even though it be 8 or 10 inches thick.

The idea of the faucet at the bottom is to permit drawing off the hot water, so that it may be used over and over again. There is no object in using fresh water each time; therefore, when the first boiler is empty enough hot water may be drawn off from the supply-can to fill it half full again for a fresh lot of combs. When first starting out it is a good plan to fill the boilers a little more than half full so that there will always be enough water for subsequent meltings.

If the work has been carefully done, when the screw is raised after the water and wax have been drained off and the follower taken out the "cheese" will be dry, comparatively speaking; and when it is dumped out into the box or basket, if a handful is taken up and pressed momentarily between the fingers, no great amount of wax will show. If only a very fine line of wax appears in the ridges between the fingers the work has been done thoroughly. It is convenient, if not absolutely necessary, to wear a pair of canvas gloves during the whole process; for when the burlap is shaken out the refuse is exceedingly hot. When shaking out the burlap, if the refuse does not shake out clean, lay the cloth over the box, inside down, and quickly rub it between the hands. This will dislodge the refuse still clinging. Now place the burlap over the press again and repeat the process. The same burlap should last for a dozen pressings. Each time, however, look it over quickly to see if there is any sign of a weak spot or the beginning of a tear. If there is, discard it and use a new cloth.

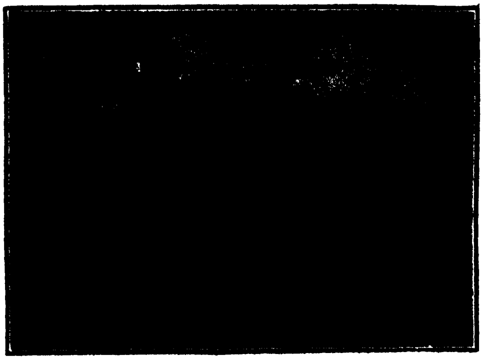


Fig. 13.—When the press is drawn out over the stove, the screws are entirely out of the way and it is therefore an easy matter to refill. A burlap 40 x 70 inches is used in order that the edges may be long enough to fold over and pin.

A heavy cloth or old sack should be thrown over the unheated can containing the supply of hot water and wax poured in from the can under the press; for the more this heat can be conserved the shorter time it will take to start a new boilerful of combs.

The final waste of wax by this process need not be over 3 per cent. There is no practical process known to the author that secures all the wax.

Rendering Wax from Old Combs in Large Quantities

The foregoing plan is entirely adequate and satisfactory for a moderate amount of rendering; but when a large amount of comb is to be handled, a larger outfit is required. There are also those who make

a business of melting up old combs for a given locality, and for such a more elaborate outfit is required.

It is not practicable to build a wax-press of a large size on the precise model just described, for the reason that the larger "cheeses" are not as easily handled, nor will they receive the same amount of pressure. Practice shows that it is much more satisfactory to use two screws over an oblong "cheese" in an oblong tank or boiler. The illustration on page 753 will show a type of double-screw press with which the author turned out 142 pounds of wax from old combs on the first day's trial, getting practically all the wax. With more practice he could turn out a larger output.

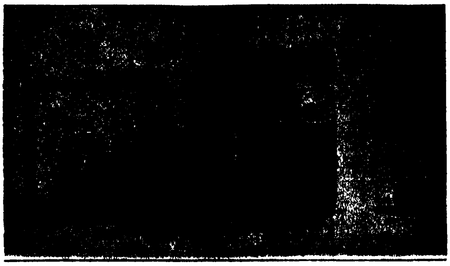
It is not practicable to heat the larger press with a small jet of steam from a small boiler, such as one could rig up for himself. However, where one can have access to a larger boiler, steam heating is all right; but as the great majority of the readers of this work will not be so situated they will have to employ other means, such as sliding the pan out over the stove to reheat. (Fig. 13.)

When diseased combs are rendered, especially those containing some honey, every precaution should be taken to prevent the bees from robbing. If the buildings can not be made bee tight, the work must be done at night, and every tool and utensil used thoroughly scalded. The refuse from the diseased combs should be burned, and the water which was used poured where the bees can not possibly get access to it.

The Amount of Wax in Combs

The question is often asked how much wax can be rendered from comb holding a given amount of honey; but it is quite difficult to answer such questions, as it makes considerable difference whether full sheets of foundation were used, and also whether such foundation was thick or thin. In general, however, it requires about 4 pounds of wax in comb to hold 100 pounds of honey, or, in other words, a pound of new comb will hold about 25 pounds of honey.

A sixteen-ounce section of honey consists approximately of 14½ ounces of honey, a little over one-half ounce of wax, and about one ounce of wood. Next is shown the result after separating the honey, wax, and wood in a sixteen-ounce section. Of course, these results, as before mentioned, are not always the same, and the different amounts vary considerably.



Honey pressed from a section; result—over 14 ounces honey, ½ ounce of wax, and 1 ounce of wood.

On one occasion the author melted over 600 pounds of candied comb honey. Keeping careful account of the weights, it was found that the percentage of honey, wax, and wood were approximately 88, 5, and 7, respectively.

Refining Beeswax

Wax cakes, as they are bought up, are usually of all grades and colors. The difference in color is due largely to the amount of impurities the wax contains. With all of the plans for bleaching or clarifying, there seems to be no practical or satisfactory way of bringing a small amount of wax to a yellow color.

Acid for refining wax on a small scale is not to be recommended, for, without proper receptacles and facilities for heating, the wax is more often injured than benefited.

Bleaching Beeswax

There are methods by which beeswax can be bleached by the use of chemicals; but for practical purposes it is unwise to attempt them. Moreover, it has finally been discovered that, for the economic uses of the beekeeper, foundation made of bleached wax is no better than, if as good as that having the natural yellow color. Yellow wax is more ductile, and therefore more easily worked by the bees; and even when used for section honey-boxes, the combs from yellow wax are about as white as those from the bleached, so that, when capped over, no one can tell the difference. But very often dealers have a call for bleached beeswax; and the only practical way for a beekeeper is to convert the product into thin sheets or small particles and then subject them to the sun's rays for a suitable length of

time. When sufficiently bleached they may be melted and caked.

Beeswax Floor Polish

One can make a very fair floor polish with nothing but beeswax and turpentine. Melt the beeswax, but be careful not to boil it. When it is melted take it off the fire and slowly stir in about an equal amount of turpentine. If it is desired to make a thinner paste, add a greater amount of turpentine. Equal parts will make about the right consistency when the wax has cooled.

For a harder polish, add to the beeswax, when it is melted, about 25 per cent of carnauba wax, then add the turpentine as before. Such a polish when on the floor is not quite so apt to be sticky in warm weather and is usually considered a more satisfactory finish than that obtained by the use of beeswax alone.

United States a Dumping Ground for Foreign Beeswax

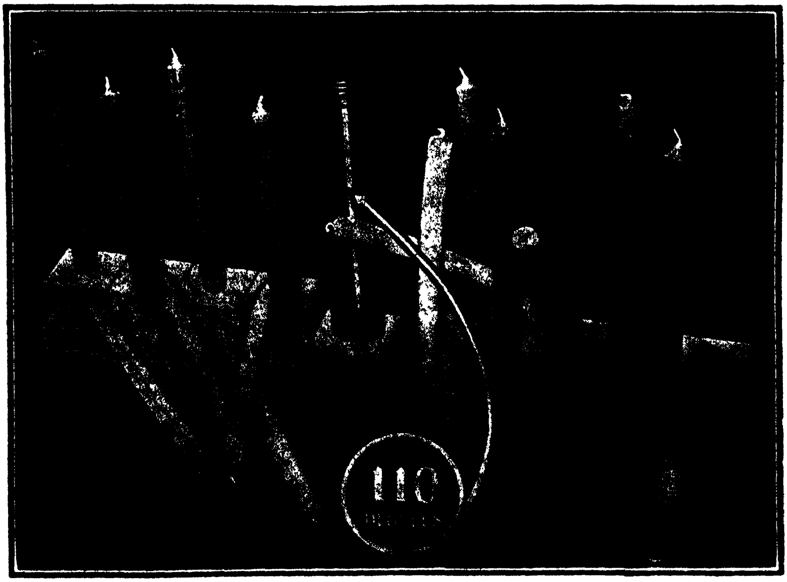
According to government figures, 3,680,410 pounds of beeswax were imported into the United States during 1931. In 1930 the amount imported was 4,312,138 pounds and in 1929, 5,482,224 pounds, exclusive of shipments from Porto Rico and Hawaii. Thus, the amount of foreign beeswax dumped into the markets of the United States is equal to nearly one-half of the domestic production according to best estimates. Some of this foreign wax is inferior to domestic wax, and has been dumped at a minimum of 12 cents per pound, thus greatly depressing the price of domestic wax. Some of this foreign wax is refined and bleached to be used for cosmetics and other special uses. This, of course, brings a higher price, usually several cents per pound above that of crude wax.

WAX CANDLES.—It is hardly more than two generations ago that ordinary tallow candles were in common use for a small portable light in connection with the old-fashioned fireplace with its log fire. Abraham Lincoln, as a boy, had only the light of a pine knot to read his books.

Candles were followed by kerosene and soon thereafter electric lights. The candle for decorative or church purposes still holds its own. No elaborate dinner table is quite complete without two or more candles burning. It is quite the fashion in these later days to light the candles especially at Christmas time and turn out all other lights.

For decorative candles paraffin and stearic acid are much used because these waxes are much cheaper than beeswax. Beeswax candles, both for decorative or church use, while more expensive, will burn longer, and give a brighter flame.

In former times beeswax was the only



Pure beeswax candles withstand high temperatures. The candles that have bent over are only 51 per cent beeswax.

wax available for candles and for hundreds of years it served the purpose. Today, though scores of cheap substitutes are manufactured, beeswax is still the most suitable material for liturgical use.

Candles for the celebration of the Mass, containing adulterants which cause smoky flames and which liberate irritating acrolin gas, should not be tolerated. According to the late Father Martin G. Hepner of St. Mary's College, North East, Pennsylvania, a beekeeper of long standing and a national authority on races of bees, the burning of beeswax candles is not only soothing to the throat but a protection to decorations and to oil paintings. Father Hepner pointed out that acrolin gas from candles containing cheap substitutes for beeswax, is not only irritating to the throat, but harmful in its effect on decorations and oil paintings. This fact is well recognized in Europe today.

Beeswax candles will not bend over in high temperatures for the high melting point prevents that. Beeswax candles do not smoke or give off obnoxious odors. Beeswax candles, while more costly at the start, are really more economical in the end, for beeswax when melted is a thick, heavy liquid which does not overfeed a wick and which permits a small, round flame so white in color that it actually gives more light and burns longer than the long, dark red, streaky flame of cheaper substitutes.

Is There Enough Wax for Liturgical Use?

Sometimes the erroneous statement has been made that the United States does not produce enough beeswax to take care of the requirements of the Church.

The annual production of beeswax in the United States is from 4,000,000 to 6,000,000 pounds. Several million pounds of beeswax are also imported annually from foreign countries. The Catholic Church in this country alone should use close to 3,000,000 pounds of beeswax a year.

Foreign vs. Domestic Beeswax

Another incorrect statement has also been made to the effect that domestic beeswax is not suitable for the making of candles, beeswax from some particular foreign country being recommended as the only wax suitable. The melting point of beeswax produced in the United States averages as high as that of any beeswax in the world. No beeswax in any foreign country excels that produced in the United States for beautiful aroma. Of foreign waxes, beeswax produced in Chile and Brazil approaches the nearest to that produced in the United States of America. It is a fact that beeswax from some foreign countries has an average melting point two to three degrees lower than that of average beeswax of the United States. It is also a fact that some foreign beeswax has a very obnoxious and unpleasant aroma.

The Adulteration of Commercial Beeswax

Because of the costly nature of pure beeswax and the extremely low price of some low grade substitutes, unscrupulous dealers have often stooped to nefarious practices, adulterating or mixing low grade waxes with beeswax and selling the mixture as pure beeswax. Some of these low grade substitutes can be bought for much less than the price of beeswax. Common adulterants are low melting point paraffins, ceresins, tallows, stearic acid, and the like. Vegetable waxes are not used as adulterants because the cost is too high. The only safe way to buy beeswax is from the producer. When it gets into the hands of unscrupulous dealers and middlemen, there is danger always.

WAX POLLUTED BY RESINOUS GUMS.—To those accustomed to think of the products of the hive as natural and pure, it may come as a distinct shock to learn that beeswax is nearly always polluted by resinous gums from propolis. While a trace of resin is almost inevitable on account of the customary layer of propolis varnish over the cell walls of the comb and over the cappings, this is not the source of the dangerous proportion of resin found in practically all of the darker colored beeswax. The author hopes to point out the reason for the serious pollution of beeswax today and suggest remedies for its elimination.

Propolis of Vegetable Origin

That propolis contains a large proportion of resinous material is perhaps not well known. A few references on the point may not be amiss.

Francis Huber, in "Huber's Observations on Bees" translated by C. P. Dadant, relates a wonderfully interesting experiment which proved to his complete satisfaction what he had long suspected. In his introduction to the experiment he says: "Propolis has similar prop-

erties to those of gum resin and it has long been suspected of belonging to the vegetable kingdom."

In "Mysteries of Beekeeping Explained," Quinby says: "By boiling the buds of these trees (poplar, balm of Gilead, etc.) an aromatic resin or gum may be obtained . . . similar to that emitted by propolis when first gathered by the bees, or by heating it afterward."

T. W. Cowan in "The Honey Bee," refers to "Propolis as a resinous substance collected principally from the buds of plants."

Langstroth in "The Hive and Honey Bee," in speaking of propolis, gives as the origin "the resinous buds and limbs of trees; the different varieties of poplar yield a rich supply."

Propolis Changes the Nature of Wax

The soluble parts of propolis enter the beeswax permanently, altering its color, aroma and texture. Cheshire in "Bees and Beekeeping," correctly calls attention to the fact that "Pure wax is perfectly white; the propolis added as a varnish is the usual, though by no means invariable, source of its yellow color."

W. B. Bray of Christ Church, New Zealand, in a booklet on wax issued in 1920, says in part:

> The reason that I have referred to propolis is that it to a great extent affects the color and aroma of the wax. A small amount of it gets plastered on old combs, and more on the frames, so that a fair amount gets rendered with the combs. . . . Why they do it, I can not say, but a good many beekeepers will, when uncapping, scrape all the propolis in with the cappings. . . . While in contact with the wax under heat, the propolis stains it and imparts an aroma.

In "The Bee World" for January, 1930, appears a summary of an article by M. Perret Maisonneuve appearing originally in "Apiculteur" for February, 1924. The following is of particular interest here:

> Propolis as gathered from hives appears in reality to be a mixture of about 70% resin melting between 90° and 100° C., and 10% of a resin melting between 60° and 70° C., and secondly pure beeswax to about 30%. The article then discusses the physical reasons for the property possessed by this mixture of remaining malleable, concluding that it has a definite composition, that it melts at a lower temperature than pure wax, and has a greater density (0.980 in place of 0.963). The propolis gathered by the beekeeper contains a proportion of wax partly because it is impossible to keep the propolis separate.

In order to find out whether parts of propolis would dissolve in beeswax at a temperature no higher than that ordinarily employed in rendering beeswax, some pure wax was selected from white cappings which had previously been tested and found free from resin. This was allowed to simmer a few minutes at a temperature not exceeding 200° F., over water containing propolis. The wax from the non-soluble parts of the propolis when filtered off, was found to have increased in weight 9%. It now showed a strong reaction for resin—easily 5% when the test was applied—and the flavor and aroma were ruined. The melting point was also 2° F. lower than that of the original pure capping wax.

In Gleanings in Bee Culture for March, 1935, C. S. Bisson, in charge Division of Chemistry, California Agricultural Experiment Station, Davis, Calif., and G. H. Vansell, Associate Apiculturist, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, point out the dangers of propolis in beeswax. They say:

"One of our samples of beeswax, originating from comb-honey scrapings, contained 16 per cent of propolis. Propolis, as shown by these and other experiments, is a relatively highly acid substance, and its presence in beeswax increases the acidity, and consequently the chemical reactivity, of the wax. Waxes carrying propolis are unsatisfactory for candle manufacture because this substance decomposes when heated and gives a char residue, which does not melt and therefore clogs the candle wick. Also, for certain other trade uses of beeswax, the occurrence of propolis results in an objectionable acidity. Within the beekeeping industry itself, propolis-contaminated wax is a source of trouble, because comb foundation made from it is gummy and consequently is more subject to stretching than foundation made from refined wax. This propolis has caused serious difficulty in the refining of western beeswax.

"Rigid exclusion of propolis from the crude wax in the apiaries should be encouraged, since producers must pay for losses in both processing and manufacturing by receiving a lower price for the crude."

Legitimate or Illegitimate Resin

Some of the resin in beeswax is legitimate—at least it can not be helped, for it comes from the "varnish" with which the bees coat the cells and the cappings that have stood in the hive for some time. If this were the only way in which resin got into beeswax, the situation would not be so serious. But unfortunately the legi-

Fig. 1.—Worker comb in a not excessively propolized frame.

timate resin is but a small part of what really exists in most beeswax today.

The "illegitimate" resin comes through the carelessness of the producer who scrapes frames, hives, supers, separators —and throws the scrapings in with the wax. The average old comb does not yield much more than four ounces of beeswax. An ounce of propolis scrapings thrown in could easily account for a five per cent pollution of the beeswax in that comb with soluble resin! Or the same pollution might occur if comb, unscraped frame and all were thrown into a vat and the wax and propolis melted together. Scrape the frame carefully, first.

Desiring to know how the weight of propolis on a frame containing an average amount compared to the weight of the wax in the comb, the comb shown in Fig. 1 was selected. The amount of propolis was by no means abnormal because thousands with more than twice the amount of propolis on the top-bar and end-bars have been found.

The comb was carefully cut out of the frame and melted. The wax was freed of the caramelized honey, pollen, etc., by filtering through tightly packed glass-wool. The propolis scraped from the frame was photographed beside the cake of wax. (Fig. 2.) The wax weighed 100.2 grams and the propolis 4.4 grams, therefore the propolis on the one frame, with none at all from the hive, super, cover, bottom, excluder or separators, was more than 4% of the amount of wax.

The wax was divided in two exactly equal parts, and also the propolis. Half the wax was melted and while melted, without boiling or even raising the temperature abnormally, half the propolis

Fig. 2.—Wax melted from comb shown in Fig. 1. Weight, 100.2 grams. This cake of wax is about 3 inches in diameter. The pile of propolis at the left was scraped from the top-bar and end-bars of the frame. Weight of propolis, 4.4 grams.

was thrown in. Much of it dissolved quickly. It was then filtered again through tightly packed glass-wool. Thus there were two cakes of refined beeswax—each representing half the wax in the comb. One-half was contaminated with resinous gums from half the propolis on the frame; the other half contained no more resinous gums than had been in the original foundation together with the little that the bees had put on the cells.

On applying the tests for resins, it was found that the half of the wax not contaminated with the propolis from the frame showed only a trace of resinous gums—not over one-half of one per cent. The flavor was pleasant, the consistency excellent. The half to which was added half the propolis, contained about 3 per

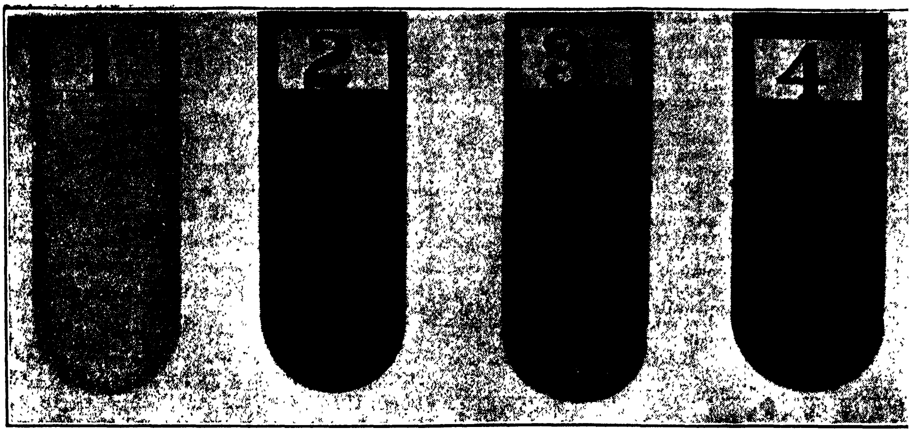


Fig. 3.—Nitric acid test on wax from the comb shown in Fig. 1. No. 1. Resinous gum solvent in which five grams of pure beeswax from white cappings was boiled. (Almost no resulting color.) No. 2. Resinous gum solvent in which five grams of pure beeswax from white cappings (with 2% common rosin added) was boiled. Decided reddish brown color shows presence of the rosin. No. 3. Resinous gum solvent in which five grams of the wax from the comb shown in Fig. 1 was boiled. (Propolis from frame not added.) Faint red color shows presence of slight amount of rosin. No. 4. Resinous gum solvent in which five grams of the wax from the comb shown in Fig. 1 was boiled. (Propolis from frame added.) Dark red color shows presence of the 3% resinous gum.

cent of soluble resinous gums. The flavor was ruined, and the wax was very sticky.

Carelessness of Beekeepers in Allowing the Scrapings of Propolis to Go Into Pure Beeswax

From this experiment it is clear that the resin legitimately added to the wax by the bees themselves is slight and need occasion no worry. That added by the beekeeper has no legitimate place in the wax and exists in such proportions as to make serious trouble.

Wax from cappings, the hardest, toughest beeswax in the world, is often spoiled

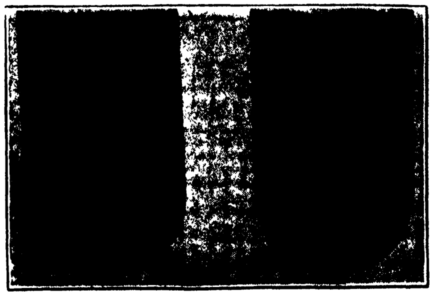


Fig. 4.—Navy test on wax from comb shown in Fig. 1. In the tube on the left the wax used was that to which the propolis on the frame was not added. The very small precipitate indicates the slight amount of resinous gum present —almost none. In the tube on the right the wax used was that to which the propolis on the frame was added. Even after refining by filtering through glass-wool, the 3% of precipitated resinous gum is plainly shown.

by carelessness in scraping top-bars and dumping the scrapings of wax and propolis in with the cappings. Here the per cent of resin is likely to be even greater than in case of wax obtained by melting up combs. Rosin is worth perhaps a cent a pound. Much crude beeswax contains 3% of soluble resinous gum from propolis. Most of this contamination could be avoided.

The Tests for Rosin

The tests for rosin are simple and reliable. Any careful student can verify them. For the first test the author is indebted to Prof. Harry N. Holmes, head of the Department of Chemistry at Oberlin College. Dr. Holmes served as chairman of a committee on the chemistry of colloids for the National Research Council for several years and he is an outstanding authority in his field. Dr. Holmes' own endorsement of the Hyde test follows:

A STUDY OF THE NITRIC ACID TEST FOR ROSIN IN COMMERCIAL BEESWAX

In Hyde's useful book, "Solvents, Oils, Gums, Waxes," published by D. Van Nostrand Company, is found on page 132 a quick and reliable test for rosin when used in beeswax. "Boil 5 grams of sample with 20 cc. nitric acid (sp. g. 1.88) for one minute. Cool, dilute with an equal volume of water, add excess ammonia and shake. Pure beeswax gives a golden, yellow solution. Rosin, if present, gives a reddish-brown solution from nitro-compounds formed."

In making this test I find it best to avoid breathing the very poisoned red-brown fumes (oxides or nitrogen). A hood or a draft from an open window is necessary. Furthermore,

care must be taken to boil gently or dangerous shattering of the acid may take place. A beaker of about 100 cc. volume is better than a large test tube. Red litmus paper should turn blue after the excess ammonia has been added.

I melted beeswax and common pine resin together in such proportions that I had standards for comparison containing 1%, 2%, 3%, etc., of rosin. The results from the test showed the greatest depth of red-brown color with the 3% rosin beeswax with the others in appropriate order. A sample of clean, white commercial beeswax was tested and the liquid after nitric acid and ammonia treatment showed only a clear yellow with none of the red-brown characteristics of added rosin.

It is interesting to note that a random sample of dark and unusually bitter commercial beeswax was found by this test to contain a distinct amount of rosin.

HARRY N. HOLMES.

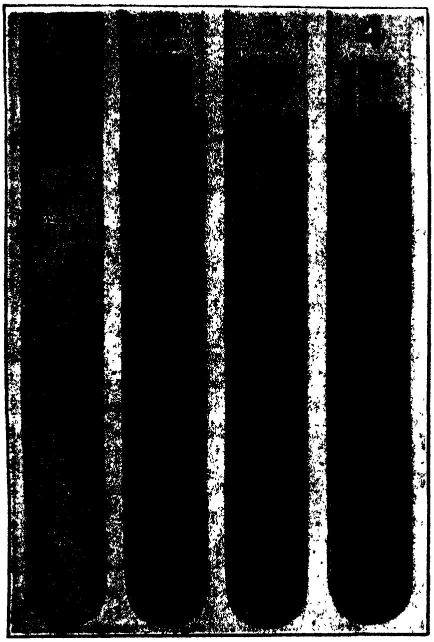


Fig. 5.—Results from beeswax examined for resinous gums by solvent test. The darker the color, the more resinous gum.

No. 1. Resinous-gum solvent in which 5 grams of pure beeswax from white cappings was boiled. (Almost no resulting color.)

No. 2. Resinous-gum solvent in which 5 grams of wax from a standard make of brood foundation was boiled. Reddish brown color shows presence of resinous gum. No comb foundation commercially manufactured is free from resinous gum, so far as the tests show.

No. 3. Resinous-gum solvent in which 5 grams of pure beeswax (as in No. 1) but with 1% common resin added, was boiled. (Slightly lighter in color than No. 2.)

No. 4. Resinous-gum solvent in which clean, light-colored, brood-comb wax was boiled. This wax has been melted out of unscraped frames or else scrapings from hives or frames had been melted with the combs. This representative sample of ordinary commercial beeswax contains 3% of resinous gum from propolis. It was soft and sticky when warm and slightly bitter in flavor.

Though many samples of crude beeswax were tested, only once was there found a sample that resulted in the golden yellow color of pure beeswax. Many makes of brood comb foundation were tested. Very seldom was there one that was free from resin or resinous gum. The worst case found showed a little darker than that of the standard wax containing 1% resin. Refining does not eliminate all soluble resins from propolis. Is it any wonder that combs sag in single-walled hives?

The other test requires at least 48 hours before one can be sure that no precipitate is forming to indicate the presence of rosin. This test appears in the Navy Department specifications for Beeswax as follows:

> 5 (c) Beeswax shall be free from fats or fatty acids, Japan wax, resin or soap when tested as prescribed under paragraph 6b.
>
> 6 (b) One gram of the wax shall be boiled for half an hour with 35 cc. of an aqueous solution of sodium hydroxide (1 in 7), the volume being preserved by the occasional addition of distilled water. On cooling the wax shall separate without rendering the liquid opaque, and no precipitate shall be produced in the liquid, after filtration through glass-wool or asbestos, on the addition of an excess of hydrochloric acid.

The Navy test is very reliable as a check, but it was found that the nitric acid test was better for a quantitative test, since it is difficult to judge the amount of a flaky precipitate suspended in a liquid. (See Fig. 6.)

That rosin or resinous gums do have a very bad effect on beeswax is clearly shown. One can test it by placing a little pile of propolis scrapings on a piece of paper and leave it for a few hours in a room heated to a living temperature—not much over 70° F. Frequently the mass will partially fuse even at such a low temperature so that it may be lifted in one piece. Some of the gums melt at an extremely low temperature. In the bee hive on a warm day everyone has seen the propolis in a semi-melted condition "ooze" when touched and string out when frames are pulled apart.

Bad Effects of Resinous Gums

Pure beeswax at living room temperatures is seldom sticky to the touch. Beeswax containing resinous gums is always sticky. The stickiness of contaminated wax is also shown by biting the wax with teeth dry. This stickiness is objectionable, not only in comb foundation, but in other products using beeswax. In floor polishes

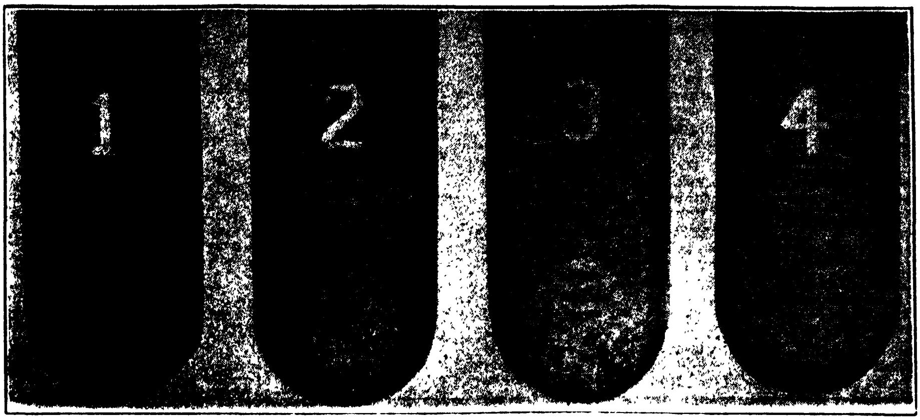


FIG. 6.—BEESWAX IS SELDOM A PURE PRODUCT.

Results of the well-known Navy Test for resin on four different samples of beeswax. One gram (1/28 ounce) used in each test. No. 1. Wax used was from white cappings. Absence of precipitate shows no resinous gum. No. 2. Wax used, from ordinary brood foundation. Precipitated resinous gums clearly shown. No. 3. Wax used, same as in No. 1, except that 2% common rosin was added. Precipitated rosin shows. No. 4. Ordinary crude beeswax. This particular sample contained between 4% and 5% resinous gums.

rosin is especially bad. Dental wax manufacturers use the nitric acid test to detect rosin in beeswax.

Beeswax containing resins is certainly more loosely put together than pure beeswax from cappings. The resin is not a binder; it makes the beeswax less resistant to strains. Propolis polluted wax softens at lower temperatures than pure beeswax. While beekeepers demand the best beeswax obtainable they have carelessly ignored a source of contamination apparently of little importance but actually accounting for the necessary variation in specifications for beeswax, and resulting in the indisputable fact that beeswax is rarely a pure product.

WAX WORMS.—See Moth Miller.

WEIGHT OF BEES.—Some very interesting experiments were conducted by Prof. B. F. Koons, of the Agricultural College, Storrs, Ct., to determine the weight of bees and the amount of honey they can carry. The results of these experiments were printed in Gleanings in Bee Culture, and the article is given here:

Some two years ago, in a leisure hour I went to my apiary and captured one outgoing bee from every hive and subjected them to fumes of cyanide of potassium for a few moments to render them inactive, and then weighed each bee upon our chemical balances—a pair of scales so delicately adjusted that it is an easy matter to weigh the one-millionth part of a pound or the one-thousandth part of a bee. From the weight of each separate bee it was a very simple problem in arithmetic to compute the number of bees in a pound. The results showed that mine, which perhaps are a fair average in size and weight, ran from 4141 to 5669 in a pound. These results you published in Gleanings, and there expressed a wish that I would also determine the amount of honey carried by a homing bee. In my research for the weight of bees I took those just leaving the hive, which naturally would represent the normal weight, without extra honey or pollen.

During the present summer (when the bees were very active) I have undertaken to carry out your request as to the amount of honey carried by a bee. My method was this. From the chemical laboratory I secured a couple of delicate glass flasks with corks, marking them A and B. Each was very carefully weighed, and the weight recorded. I then went to a hive, and, with the aid of a pair of delicate pliers, or pincers, I captured a number of incoming bees and dropped them in flask A. I then secured about an equal number of outgoing bees in flask B. These were then taken to the laboratory immediately, and each flask again weighed, after which the bees were carefully counted and released. This operation was repeated quite a number of times, not on the same day, but as opportunity offered, and when the bees were bringing in an abundance of honey. I captured from 20 to 45 bees for each flask at each trip, aiming to have as nearly as might be, the same number in each flask on any particular trip. I always weighed the flasks before starting out, lest some little bit of soil or stain, or even moisture on the glass, would render the results less accurate; I also always allowed any moisture condensed upon the inside of the flasks, while the bees were confined, to evaporate before weighing for another trip. I then treated my results as follows: From the weight of flask and bees I deducted the weight of the flask; the remainder I divided by the number of bees confined on that trip. This gave me the average weight of the bees captured at that time. The average weight of the bees in flask A, or loaded bees, was always greater, as it should be, than the average weight of the bees in flask B, or unloaded bees. The difference between these two weights gave me the average amount of honey carried by that lot of bees.

Mine are Italian and hybrid bees, but I made no attempt to determine the difference in the amount carried by the different swarms or

breeds. I kept no record of the swarms except that I guarded against going to the same hive for a second lot of bees. A considerable difference does appear, but probably that arises in part from the abundance or scarcity of honey on any particular day when the colony was visited. My aim was to secure reliable results, as nearly as possible representing the average amount of honey carried by bees.

The following is the result of weighing several hundred each of returning and outgoing bees. The smallest number of bees necessary to carry one pound of honey, as shown by my results, is 10,154; or, in other words, one bee can carry the 1-10,154 (one ten thousand one hundred and fifty-fourth) part of a pound of honey; and the largest number, as shown by the results, required to carry a pound, is 45,642; and the average of all the sets weighed is 20,167. Perhaps, then, it is approximately correct to say that the average load of a bee is 1-20,000 (one twenty-thousandth) of a pound; or, in other words, if a colony has 20,000 bees in it, and each one makes one trip a day, they will add the pound to their stores. Of course, not all the bees in a colony leave the hive, the nurses remaining at home, hence necessitating more trips of those which do "go a-field."

I also repeated my observations of two years ago on the weight of bees, and found that my numbers ran from 3680 to 5495 in a pound, and the average about 4800, the same as in my former test. I likewise secured the following on the weight of drones: Of a dozen or more weighed, the largest would require 1808 to make a pound and the smallest 2122, or an average of about 2000 drones in a pound, over against nearly 5000 workers.

B. F. Koons.

Agricultural College, Storrs, Ct., Sept. 3, 1895.

Both Professors Gillette and Lazenby, the former of the Colorado Experiment Station and the latter of the Ohio State University, conducted a series of experiments which closely approximated the figures of Professor Koons, and it may be assumed they are correct.

In round numbers there are 5000 bees to a pound. Single swarms have issued that have contained as high as 10 pounds of bees. The swarm itself would, therefore, contain approximately 50,000 bees, most of them old or fielders. The number of bees left in the hive probably would not exceed 4 to 5 pounds of young bees, making a total population of about 75,000. Some of our best beekeepers, however, are now taking the view that colonies can be built up to 100,000 individuals and that such colonies will be very profitable; but, generally speaking, a good colony would not go much above 75,000 to 80,000 bees. Of this number there would be between 4 and 5 pounds of bees that would be too young to go to the field. If so, about a third of the entire force would be young bees, and the other two-thirds would be fielders. This proportion would prevail only just before the main honey flow. In the middle of spring, when breeding is at its height, half or possibly two-thirds of the bees would be young or nurse bees. During winter in the northern states there would be no young, and all of them would be able to fly to the fields if the weather conditions would permit.

Again, in a colony population of 75,000 individuals there might be, in the height of the honey flow, 40,000 to 50,000 bees in the air or in the field at one time. Sometimes, during the middle hours of the day, when there is a great rush of incoming nectar, a colony will seem to be almost deserted; and toward night it will soon be overcrowded.

Professor Koons says that, while 10,000 bees may carry a pound of nectar, 20,000 would be more nearly the average. Much will depend on the strength of the honey flow, and on how much time the bees take on each trip.

While the average colony in the height of the honey flow will not bring in more than 4 to 5 pounds of nectar in a day, it may bring in as much as 20 pounds. Some cases are recorded where as high as 66 pounds have been gathered; but these cases are rare. Assuming that a bee can carry half its own weight in nectar, and did that all day, a colony of 40,000 field bees might make a gain of 20 pounds to the hive, each bee making five trips. If, however, they brought in only one-half that amount per trip, they would have to make at least ten trips per day. If nectar were very abundant those same bees might make twice that number of trips, or bring in a total of 40 pounds of nectar. It can hardly be assumed that all bees would be equally industrious. When bees are robbing, filling up on fully ripened honey, they will make thirty or forty trips a day. A bee can fill up on honey in the space of a minute or two. It could then hike back to its hive, unload, and return.

If it takes 10,000 bees to carry a pound of nectar, one bee could carry only half its own weight. Some work has been done to show that a single bee can carry an amount of honey equal to its own weight. Honey, it will be understood, would make a great deal less bulk. If the honeybee had a larger sac it might carry a much larger amount of nectar. When Professor Koons speaks of 10,000 bees carrying a pound of honey, he, of course, means nectar.

These figures will not mean much to the practical beekeeper unless he realizes

that the force of fielders should be, in the height of the flow, three or four times as large as the number of young bees acting in the capacity of nurses, comb-builders, and bees keeping up the ventilation in the hive, by which the incoming nectar can be evaporated. It is right here that the very populous colony—from 75,000 to 100,000 individuals—shows its great superiority over a colony of 30,000 to 40,000 individuals. If it takes 20,000 or 25,000 bees out of a total population of 40,000 to keep house, it is clear that that colony will not gather a large amount of honey. But if the beekeeper has made his calculations so as to have a large force of fully matured bees at the beginning of the honey flow, not less than 75,000, the chances are he will get a crop if the honey is to be had. (See page 136.)

In the way of a summary, it may be said that there are approximately 5000 bees to a pound. While this number could carry a whole pound of honey, they carry from one-fourth to one-half pound of raw nectar. The number of trips a bee will make in a day will vary from five to a dozen or more, averaging, perhaps, from five to ten trips during the honey flow.*

WEAK COLONIES, TO STRENGTHEN.—See Uniting, subhead Alexander Plan, also Nucleus and Building Up Colonies, also Package Bees.

WHITE CLOVER.—See Clover.

WHITE HOLLY.—See Gallberry.

WILD SUNFLOWER.—See Sunflower.

WILLOW (*Salix*).—This is a very natural or clearly defined genus of shrubs and trees found chiefly in the north temperate and arctic zones. Of the 161 described species, about 78 occur in North America, more than 30 of which are in eastern America.

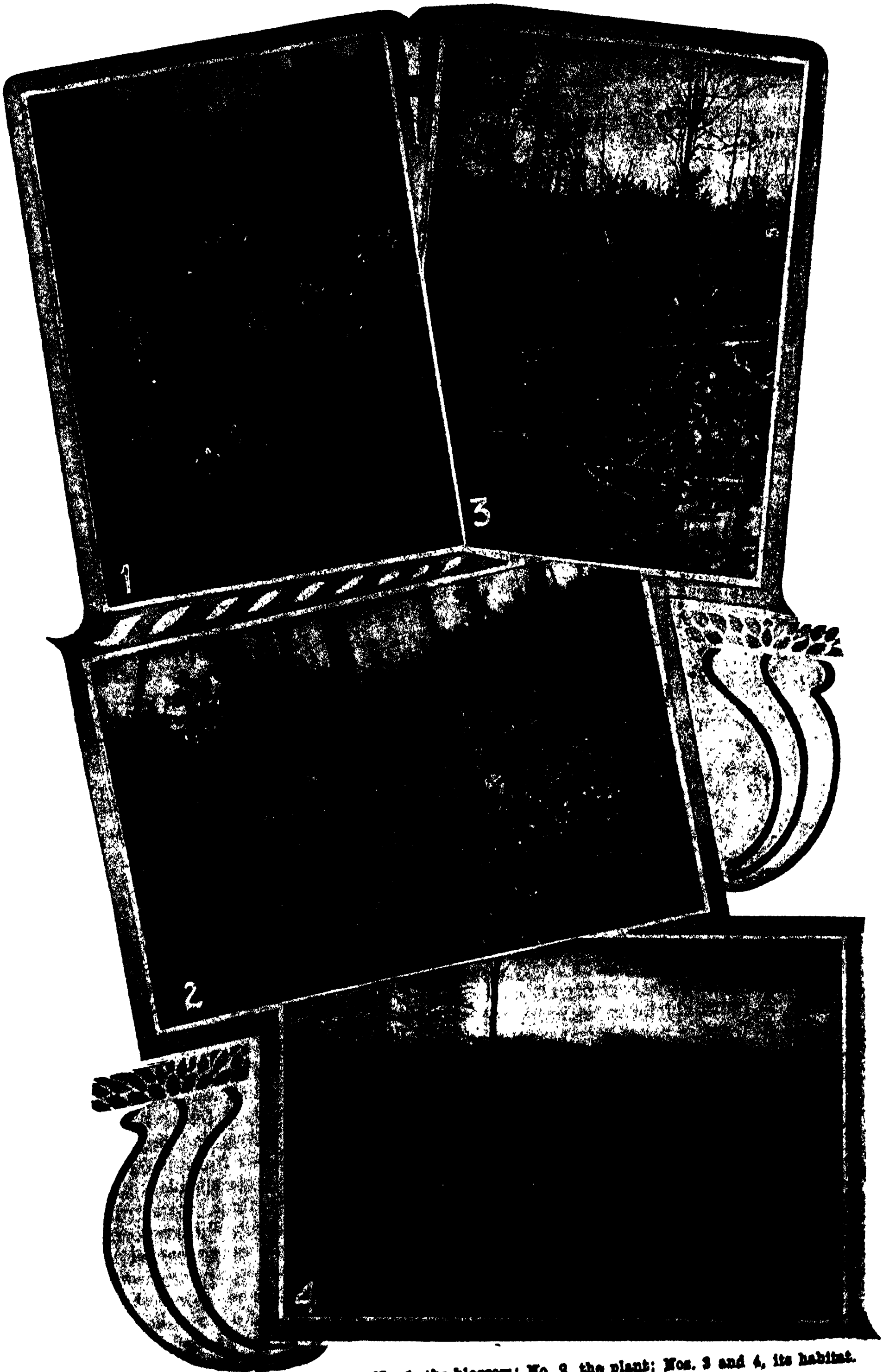
*Some very interesting data on the number of trips per day made by bees in gathering nectar, pollen, and water are given in Research Bulletin No. 108, by O. W. Park, of the Agricultural Experiment Station at Ames, Iowa, and by A. E. Lundie, U. S. Department of Agriculture Bulletin No. 1328. According to these authorities, the average number of trips per day a bee makes for nectar is between 7 and 15. Under favorable conditions the higher figure will be reached, and it may go as high as 30. Under unfavorable conditions the number of trips per day will be 7 or under. The number of trips for pollen is somewhat under the figures for nectar, and for water much ever, in some cases as high as 100 per day.

All of our species furnish both pollen and nectar, but it would, of course, be useless to look for pollen on pistillate shrubs or trees. The nectar is freely secreted in both kinds of flowers on the tips of minute flat glands, which in the pistillate flowers may be found at the base of the ovary. As our early willows attract great numbers of insects, the supply of nectar may be temporarily exhausted; but it should not be concluded, therefore, that it is wholly absent. If a branch of flowers be broken off and carried into the house and placed in water, and the nectaries examined under a microscope after 24 hours, nectar will probably be found in abundance.

The earliest willow to blossom in New England is the glaucous or pussy willow (*Salix discolor*). On a calm warm day the sweet odor may be detected several rods away, and a swarm of insects may be seen hovering about the bright-yellow sprays of bloom.

The early-blooming willows are visited by large numbers of honeybees, both for pollen and nectar, and are of great value to the beekeeper. One of the commonest willows in the eastern states is the pussy willow, which is a large shrub growing on river banks. In Massachusetts it blooms along the last of March and early in April. In Georgia the black willow (*S. nigra*) grows along the streams throughout the state. It blooms in March, and in a few localities yields a surplus of honey of medium quality. The black willow is also common in Texas, where it is valued for both pollen and honey. In California, Richter says, the willows yield a surplus in several counties. It is a dark-amber, bitter honey. See "Honey Plants of North America."

WILLOW-HERB (*Epilobium angustifolium*).—Fireweed. Indian pink. Rose bay. A perennial herb, 2 to 8 feet tall, with long lance-shaped leaves, and handsome red-purple flowers. After forest and brush fires it springs up in great abundance, and flourishes for about three years, when other plants crowd it out. Wild raspberry, another good honey plant, is one of the first plants to replace it, and goldenrod, asters, Canada thistle, and various shrubs also soon spring up and occupy the land. But the length of time fireweed offers a good location for beekeeping varies greatly in different parts of the continent.



Willow-herb of northern Michigan. No. 1, the blossom; No. 2, the plant; Nos. 3 and 4, its habitat.

Distribution of Willow-Herb

Willow-herb is abundant in New England and in northern Michigan, Wisconsin, and Minnesota. A few years ago there were thousands of acres of this plant in northern Michigan without bees to gather its sweetness. A large part of northern Michigan (the Lower Peninsula) was formerly covered with white and red pine, which has now been largely cut for timber.

Honey Flow

Willow-herb blooms in July and August, but the period of blooming is influenced by altitude, latitude, and rainfall. The flowers are usually red-purple in color, but at Monteith, Ontario, Sladen observed solitary stalks of a white-flowered variety. The nectar is secreted by the green fleshy top of the ovary, where it is protected from rain, and is yet easily accessible to insects. On the outer side the nectar is enclosed by the dilated bases of the stamens and above by a ring of hairs around the style.

Cool nights and warm days, as in the case of many other honey plants, cause the secretion of the largest amount of nectar. The honey flow lasts longer than that of clover. See "Honey Plants of North America."

Willow-Herb Honey

Hutchinson, whose knowledge of willow-herb honey was based on an experience covering many years, described it as follows: "Willow-herb furnishes the whitest and sweetest honey I have ever tasted. The flavor is not very pronounced, but there is a suggestion of spiciness." According to Sladen, "Fireweed honey is almost water white, has a good density, and a very mild flavor. It granulates soon after extraction." In some instances the honey has been described as being as clear as water. The comb is also very white and tender.

WINTERING.—Under the head of Absconding Swarms, in the opening of the book, and under the subject of Uniting, the beginner has been cautioned against dividing, and trying to winter weak colonies. See Absconding in the Spring, under the head mentioned. In regard to keeping bees warm through the winter with artificial heat, see that head; also Temperature. Concerning the effects of different kinds of food or stores on the welfare of bees during winter, see Aster, Dysentery, Honeydew, Spring Management, Feeding and Feeders, Food-chamber, Candy for Bees, and Spring Dwindling. On the subject of fixing the size of the entrances, see Entrances to Hives, Ventilation, and Swarming. Some very important information is given under Entrances, and it would be advisable to read that article before one takes up the matter further here. For management in the spring see Spring Management, Dysentery, and Spring Dwindling. For a consideration of the different sizes and shapes of frames for wintering, see Hives, also frames. For the discussion of double-walled or chaff hives, see Hives. For the consideration of windbreaks, see Windbreaks, under Apiary, and further on under this head. For the effect of honeydew on wintering, see Honeydew.

Two Methods for Wintering Bees

One is called the indoor plan and the other the outdoor. Which one the reader shall use depends entirely on the locality, the climate, and the kind of winter stores. Where the winters are extremely cold, with continuous freezing weather, without (or almost without) a break through the months of December, January, February, and March, the indoor plan may or may not prevail.

In the milder climates, such as may be found south of the Great Lakes and north of the Ohio River, outdoor wintering is almost universal. In these the ordinary double-walled hives give excellent results. In a general way it may be said the indoor plan should never be used where the stores are of inferior quality or where the winters turn from mild to severely cold, the variations taking place every week or two weeks, unless the cellars or repositories are wholly underground, with three or four feet of earth on top. In the western provinces of Winnipeg and Saskatchewan, North Dakota, Wyoming and Montana the cellar plan is used.

While the outdoor method demands double-walled hives, winter cases, or something to protect the hives on their summer stands, and a location protected from the prevailing winds, the average beekeeper, especially a beginner, will succeed better by this method than by the cellar plan.

From 75 to 90 per cent of the bees are wintered outdoors, because it takes less skill, less labor and is more sure of good

results in the spring. Where it is so very cold as to require cellar wintering or quadruple cases as in North Dakota and Winnipeg, Canada, there is a tendency to let the few bees that are left die in the hives in the fall and put package bees from the South on the combs the following spring. (See Package Bees.) The cost of four-colony winter cases or cellars, which must be entirely under ground, the cost of moving the bees from their summer stands into the cellar and then out again, the weakened condition of the old bees after their long confinement, all argue for a two-pound package of young and vigorous bees and a young queen. In other words, these young bees from the South will outstrip the old ones wintered over. This is not necessarily the opinion of the author, but the opinion of the Canadian government Provincial Apiarist, L. T. Floyd, at Winnipeg.

When the outdoor plan is used it is fair to state that, after a very severe winter in which the mercury stays below the zero point for weeks at a time, and when spring is very late, with a warm spell followed by a very severe cold one, losses may be heavy, even among the most experienced beekeepers. But these losses can, to a very great extent, be minimized, even during very cold winters, provided the colonies are supplied in the fall with a young queen, young bees, ample windbreaks and a food chamber. (See Food Chamber.) Good natural stores well sealed and plenty of them are very important.

It will be the purpose of the articles that follow to set forth as nearly as possible some of the difficulties to be encountered, so that the reader may intelligently undertake the problem. Fortunately, the very severe winters referred to do not occur more than once in 10 or 20 years, when for some reason the whole year seems to be thrown entirely out of balance. At all other times, if one follows carefully the directions here given, his losses will not exceed ten per cent, and he may keep them down as low as two per cent. Some have wintered their bees winter after winter with a loss not exceeding five per cent, if the one year in ten which proves abnormally severe is left out of the calculations.

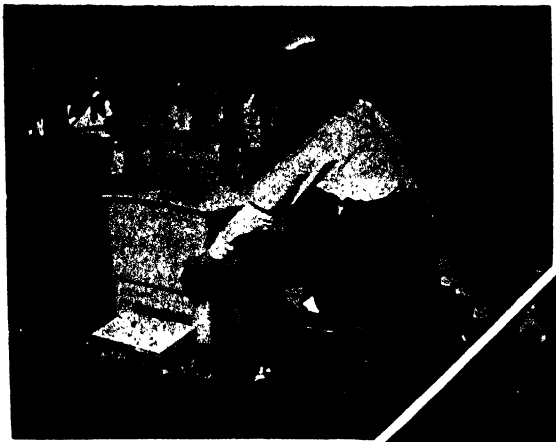
WINTERING OUTDOORS. — As already explained, this is simpler, and the principles involved help to lay the foundation for the more difficult problem of indoor or cellar wintering. The outdoor plan is much the safer for the beginner and for the expert beekeeper in the average locality. In former years the indoor plan was used much more extensively than it is now. As already mentioned, the great majority of beekeepers wintering out of doors and north of latitude 40 should use some packing around the hives if not already double-walled with packing between the walls. An important factor for both methods is a large force of young bees reared during the latter part of summer or early fall. This, of course, means a young queen in late summer or early fall. A colony, no matter how strong, if made up of old worn-out bees, with very few young, may die before spring, or reach such a weakened condition as to become practically worthless for the following season. As a rule, in the northern states brood-rearing, unless there is a young laying queen, slows down after the honey flow. This is perfectly normal where there is no late summer or fall pasturage, such as buckwheat, asters, or goldenrods; but during the latter part of August and early part of September brood-rearing should begin again. If the colony is supplied with a young queen and a food-chamber, enough brood will be reared to supply the young bees. Even with an old queen and a food-chamber there should be enough young bees to make a fair colony in the spring. (See Food Chamber.)

If the cluster is too weak, it should be given a package of one or two pounds of young bees from the South. (See Package Bees.)

Necessity of Protection

It is not safe to attempt to winter bees outdoors in single-walled hives north of 40 degrees north latitude unless the windbreaks are ample and the colony strong with a food chamber and young bees, and even then moderate packing helps. While the colonies may come through in a weakened condition, the shock of the exposure will be so great that they probably will not be good for much to gather honey. It is also highly important that the hives be protected from high winds, and that the walls surrounding the hive be double and warm. Colonies in double-walled hives out in the open, and where there is a strong windsweep, may not survive, while those in single-walled hives

screened by buildings, woods, or dense shrubbery, may winter well. It would appear that protection from the prevailing winds is just as important as having the walls of the hives double. Special double-walled hives are manufactured, having the space between filled with chaff, planer shavings, leaves, or other suitable material. The hive is so arranged that a tray of packing under the cover helps to retain the heat of the cluster, thus requiring a smaller consumption of stores to keep up the necessary animal heat. It is desirable to have the bees, so far as possible, enter a state of quiet. An extremely cold spell will make it necessary for this cluster to raise the temperature, as explained under Temperature of the Cluster in Winter. When a colony is so poorly protected or so weak that it has to go into a state of activity and overeat, the bees will become distended, and dysentery or purging is almost sure to follow. This condition, occurring in midwinter or early spring, means the death of the colony, as there is no cure for it but warm weather. (See Spring Dwindling and Dysentery.)



A deep telescoping cover to set over the packing tray for outdoor-wintered colonies is preferable.

Wintering in Double-Walled Hives

For the northern climates subject to zero weather at times, with more or less snow and a large amount of frost extending perhaps two feet into the ground, nothing short of double-walled hives, such as are described under the head of Hive-making, or packing-cases, should be used.

There has been some discussion as to whether these winter hives should have bottom packing or not. From some experiments with electric bulbs, apicultural experts in the Bureau of Entomology came to the conclusion that there is a great advantage in having the bottom packed, as well as the ends, sides, and tops. In a climate not generally subject to continued zero weather these double-walled hives with two inches of packing on the sides, ends, and bottom, and four inches on top, with a restricted entrance, give excellent results. They save brood in early spring and late fall. In the long run they are cheaper because they save labor. The top of the hive should have a tray containing four or five inches of planer shavings or leaves, as shown in the cut below. During the coldest part of the winter the entrance should be contracted (provided there is bottom packing) to a space one inch wide by three-eighths inch high.

The top packing consists of a tray filled with planer shavings. Buckeye hive.

The top of the hive should be covered with a tray to hold the packing material. The entrance is provided with a detachable cleat having different sizes of openings. During summer the cleat is removed entirely. In the fall the cleat is inserted with the narrowest opening. (See Entrances.) Just above the main entrance there will be found a ⅝-inch hole

in all modern double-walled hives, penetrating to the inner chamber. This is used as an upper winter entrance, so that, if the lower entrance becomes clogged with dead bees, snow, or ice, there will still be an opening for ventilation and for the egress of bees during warm days in winter when bees can fly. In extremely cold weather the lower entrance can be closed entirely.

This upper fly-hole entrance is a valuable feature in a permanent double-walled hive. Such a hole is not practicable where a detachable winter case either of wood or paper is used.

If a colony is as strong as it should be, it should have a food chamber with a packed rim as shown in the cut. On top should be placed the tray and cover.

The author does not recommend wintering weak colonies or nucleus in single or double-walled hives. Better unite or put in a package of two pounds of bees and put on a food chamber. (See Food Chamber.)

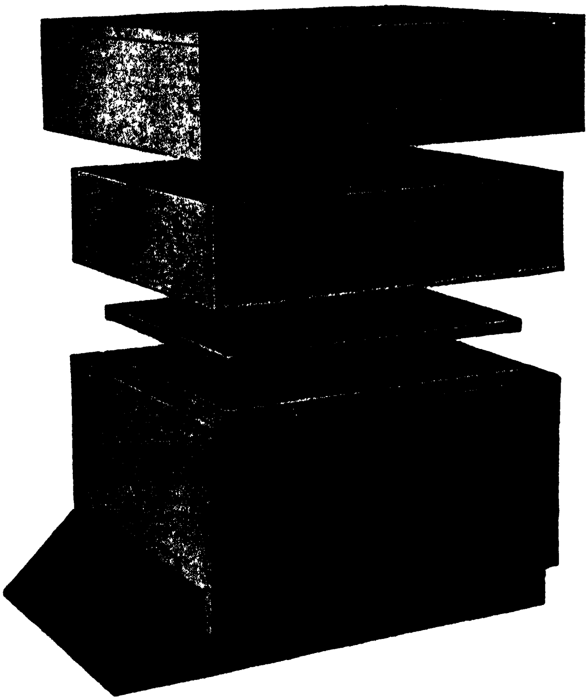
Winter Bees in a Shed

Some beekeepers practice putting their colonies under a shed or a series of sheds, packing straw between the hives, on top of them, and behind them. It is customary to have the front of the shed

Buckeye hive with packed rim to set over a food-chamber.

face south or east, leaving the back toward the north or west, or toward the direction from which the prevailing winds come.

The objection to the plan is the ex-



The Buckeye hive, with telescoping cover, tray with shavings, inner cover, and built-in double-walled and packed hive-body. Note small circular winter entrance above regular at the bottom. If the colony is as strong as it should be, a food chamber of natural store on top of the brood chamber will help greatly.

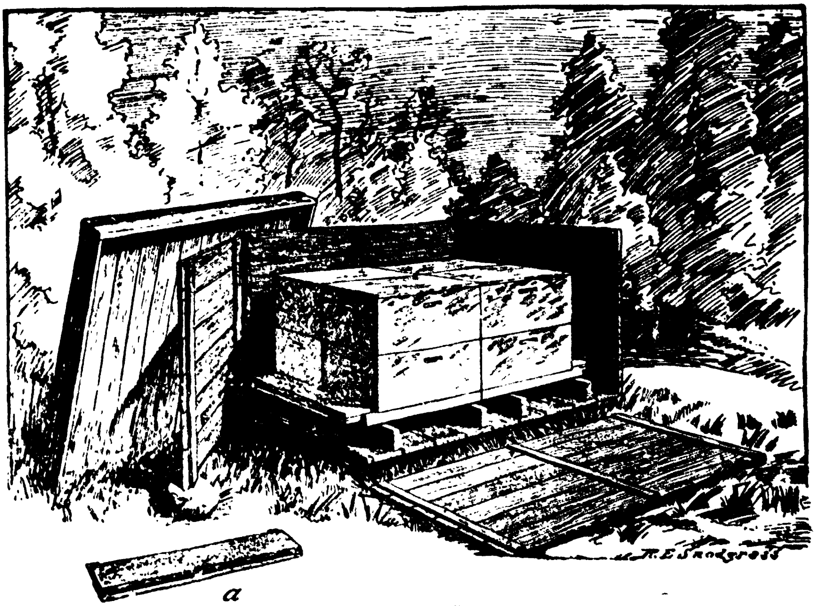
pense and the trouble of moving the bees out of the shed for summer handling. There is a further objection, that it is not practicable to pack the front of the hives that are left exposed. Taking it all in all, the plan is not recommended.

Wintering Bees in Tenement or Quadruple Cases

In climates where the winters are very severe, where the temperature goes down to zero and stays around that point for weeks at a time, much more protection is required than for those methods already described. There should be at least six inches of packing around the sides and ends of the hives, at least four inches under the hives, and ten inches on top.

It was believed at one time that this four-hive winter case was the best method of wintering bees outdoors. It was argued that if a little packing around and on top of single-walled hives was a good thing, more would be better. This logic still holds good for climates where there is continuous cold with zero or sub-zero temperatures. Where such extreme cold prevails, it is a question whether cellar wintering, cellars below the top of the ground, would not give better results or perhaps better still, let the bees die in the fall and replace with package bees in the spring as is done in Winnipeg in Canada. (See page 577.) Be that as it may, the quadruple or four-colony case is giving way to the single colony packing in the milder climates north of latitude 40 and to cellar wintering in localities where the winters are severe and continuous. At the present rate the big case will disappear entirely. In Canada and in the great Northwest in this country where the quadruple plan of wintering was in quite general use, it has, to a large extent, been replaced by cellar wintering or by colonies packed singly in the less expensive paper cases described further on.

Theoretically, the quadruple case ought to be effective. The four colonies put together should conserve each other's heat. There is only one side and end of each hive toward the outside. So much packing material should be more of a protection than less packing. All this is true to a certain extent, but unfortunately there are a number of objections to such a large case and to so much packing.



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QUADRUPLE PACKING CASE.

This is a plan used by a few beekeepers for wintering bees outdoors in the extreme north in single-walled hives. It consists of a winter case made up of panels which are held together by means of screws or nails at the corners. This case should provide six inches of packing around the sides and ends, at least four inches under the bottoms of the hives, and at least ten inches on top. (From Government Bulletin No. 1222.)

First, the big case is expensive, and while it should last 10 years, experience seems to show that it is in a ramshackle condition at the end of five and unfit for further use. So much handling in the spring and fall every year, so much exposure to hot sun and rain inside and out during summer when piled up, soon makes it a wreck. Regular double-walled hives that afford protection summer, spring, fall, and winter are actually cheaper and will last much longer. Second, these big cases are cumbersome and unwieldly. On the average, it takes two men a whole day to pack and unpack a yard. Third, immediately after packing, the flying bees for several days are in confusion. The general appearance of the packed colonies is so different from the four colonies unpacked that the bees have difficulty in locating their entrances, although from the points of the compass, they are in the same relative position. This causes drifting and the killing of some bees. Fourth, in early spring when the bees come out on fly days there is much drifting. Bees are quite inclined to go to the entrances where there are the most bees flying. This means that the weaker colony on one side of the case will become weaker and the one on the other side stronger. The one has too many bees and the other too few. Placing a board or hive cover between the entrances does not altogether correct the trouble.

Fifth, many beekeepers don't like the arrangement of four hives all in a group in the summer time. The close proximity of the hives interfere, they say, in the handling of the colonies. Sixth, one pair of entrances may be toward the south or east, but the other pair must necessarily point in the opposite direction or toward the north or the west. It is always desirable to have colonies in winter with entrances toward the south or east. Seventh, too much packing sometimes does more harm than good. Excessive packing holds the cold and does not let the heat of the sun on warm days penetrate to the cluster so that it can expand and get on to fresh stores. Some work done by Prof. H. F. Wilson and his students in bee culture at the University of Wisconsin showed that colonies with six inches of packing did not winter as well as those colonies having only two inches of packing.

The outstanding fact is that the four-colony case that seemed to be all the rage at one time is now giving away to the much cheaper paper case with only one colony or to the regular factory made doubled-walled hive permanently packed.

An Inexpensive Winter Case Made of Paper

Mention has been made of the cost of the quadruple packing-case. One can make a very good substitute out of paper, the cost of which will be very little. For material, slater's felt or a cheap grade of ordinary tarred paper can be used. The length of a roll obtained at a hardware store should be such that it would be possible to pack a one-and-one-half or two-story hive without unnecessary cutting or waste of paper. A roll 36 inches wide is about right for a two-story hive, and yet leaves sufficient room on top for packing material. One can pack either one hive or two, but the tendency in later years is to pack single and thus avoid drifting as explained under quadruple cases, and under Drifting, page 229.

The tarred paper should be cut into lengths long enough to make a cylinder that will slip down over the entire two-story hive, and yet leave sufficient room for packing. Each length of paper is rolled up into the form of a cylinder, and then pasted together with a lap of six inches, using melted asphalt, such as is used for roofing purposes. This is put on with a stick having a ball of old rags on one end. This is dipped into the hot asphalt and applied to the laps. When the ends are put together they stick instantly. Enough cylinders of paper should be made up in this way to cover all of the colonies to be packed. Each of these cylinders is then creased or folded so that there will be four square corners. The shape will then be rectangular in the form of a paper box without top or bottom.

If the ground on which the hives stand is dry, one of the tarred-paper boxes is slipped over the hive. Folds of common newspaper are placed at the corners of the hive to hold the case around the hive and yet leave a space of three, four, or six inches. Dried forest leaves are then poured in around the hive, but not until after a bridge is made over the entrance, or entrances, so that the leaves or packing material will not close them up. Dry leaves should always be used next to the ground. The remaining space can then be filled with more leaves or with planer

shavings. Enough are put in so that there will be two or three inches of packing around the sides and ends, and four or five inches on top.

The top of the tarred paper is then folded down, and over this is placed a square of tarred paper that has been painted on the under side with hot asphalt. This square of paper makes the roof, and, when pushed down into place and held there for a moment, will cool and stick, thus making a permanent cover. The hot cement not only holds it, but prevents rain or snow from working in.

If, on the other hand, the ground is soggy or moist, it would be wise to put a square of tarred paper on the ground, after taking the hive away. This should be large enough to make a tray that can fold up under the paper box that is later placed around the sides and ends of the hive. If it is desired to put on bottom packing, two inches of leaves, evenly spread, can be placed on this tarred-paper tray, and then the hive set on top. After the paper box is in place and the corners are pushed out by the newspaper padding, the tarred-paper tray at the bottom is tucked under so as to keep out water. After putting the packing material in, the top is then cemented on in the manner already explained.

The next step is to cut a slit in front of the entrance of each hive. The location of the bridge or entrance can be determined by feeling with the fingers over the paper. A sharp knife can then cut out an opening of the exact size desired. The edges of the paper are then cemented to the bridge. If asphalt is melted and put on with a brush, the paper will be stuck immediately.

It is needless to say that a hive put up in this way will look much nicer than when the paper is held on with strings and slats. After the winter is over and the bees are unpacked the tarred paper can be burned, and the next year a new supply can be secured, as the material is so cheap.

Which Method of Packing Should be Used?

The answer to this will depend upon conditions. If the climate is not too severe, and if labor is expensive and hard to get, the regular double-walled hive is much cheaper in the long run. The average business or professional man, or the one who is engaged in some other pursuit, will find that the cost of the labor, the single-walled hive, and the packing-case will be more than the cost of the double-walled hive divided by ten or twenty, according to the number of years that it is used. Even the beekeeper who has no other occupation could spend his time much more profitably in putting up and selling his honey than in packing his bees in paper.

Granting that the double-walled hives cost more, the difference will be met many times over by the saving in brood. In the spring or in fall, when there is liable to be a sudden drop in temperature, there is often a large amount of brood killed that would otherwise be saved in a double-walled hive. This lost brood would make quite a difference in the honey crop.

Again, if one is a professional or business man, who keeps his bees for pleasure as well as profit, and has extra time at his disposal after office hours, the labor item cuts no figure. If, later, he finds that the business is so pleasant and profitable that he desires to make increase in the number of colonies, it would pay him well to buy double-walled hives from that time on, provided that the climate is not too severe during the winter. When one goes into the business in a large way, so that he can not do all of the work, he will find that equipment that will save in the cost of hiring help will pay a handsome dividend on the first cost.

If, again, one is located where the winters are very severe, where the temperature ranges around the zero mark for weeks at a time, it will be advisable to winter the bees either in the cellar or in heavily packed wooden cases. The ordinary factory-made packed double-walled hive, unless there is deep snow that continues through the winter, would hardly be adequate protection in such a climate.

Non-Porous Covers or Absorbing Cushions

There has been considerable discussion in the bee journals over the question of whether there should be loose porous absorbing cushions or other material placed above the cluster of bees so that the moisture from a cluster can pass up into the packing; or whether, on the other hand, the top of the hive should

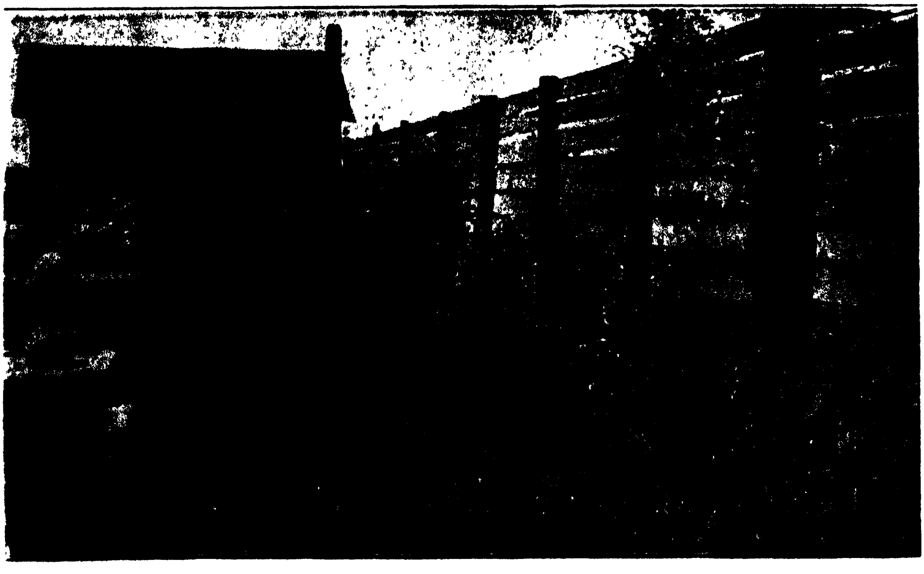
have a thin board or super cover sealed down. If there is danger of the entrance becoming closed by deep snows or ice for weeks at a time, upward ventilation through porous packing would probably be safer, for bees must have air.

It is a recognized principle in science that warm air can hold a large amount of moisture. This moisture is immediately condensed when it comes in contact with a cold surface, such as the side of a pitcher of ice water on a hot day. The same principle applies in a beehive. If the inner walls for any reason become cold, and the air in the hive, heavily laden with moisture, is warm, this moisture is condensed, forming drops of water on the walls and the underside of the cover of the hive. On a cold day there is nothing to prevent moisture from forming on the inside walls of the hive if they are not properly packed or protected. In very cold weather, if the packing material is not thick enough the cold will penetrate into the inner walls, resulting in condensation. It is, therefore, plain that, in order to stop condensation, there must be enough packing material to keep the inside of the hive warm. In the colder climates, as in Canada, it has been the practice to use absorbing cushions right over the cluster of bees in order to let the moisture from beneath escape upward. It would be better to use enough packing material so that the cold can not penetrate, when no condensation would form either with or without a sealed cover. If the packing material is not enough to prevent condensation inside of the hive, the moisture will pass up through the material and freeze, thus making a mass of semi-ice. Taking everything into consideration, the question whether one should use the sealed cover or not is unimportant. But it is important to have enough packing material so that the cold can not penetrate into the inner part of the hive, causing condensation or frost. It is equally important to have the entrance contracted enough to prevent the cold air from blowing in, thus defeating all the good that might accrue from plenty of packing.

Importance of Windbreaks

Next to young bees, a young queen, natural sealed stores, and winter protection, windbreaks are prime requisites.

In various places leading up to this, especially under the head of Apiary, mention has been made of the importance of windbreaks to screen the hives from a strong windsweep. A bad location for wintering bees outdoors is on top of a hill with a clear stretch of country for a mile or two in the direction of the prevailing winds. Although the bees may be



Peter Sowinski's windbreak made of fence boards spaced about two inches apart and nailed horizontally to fence posts eight feet above the ground. Open spacing breaks the force of the wind better than a solid fence.

nicely housed in double-walled hives or packing-cases, the high winds during cold or chilly weather may and probably will have a disastrous effect on the bees. Many of them, lured out by a bright sunshine on certain days, will be caught by a chilling blast. They will drop to the ground; and, unless there is a change in the temperature or the wind, they will never come back. On the other hand, colonies screened in by farm buildings, by a growth of woods or dense shrubbery, or by a high fence, will be able to withstand the cold much better.

Likewise there may be certain spots in an apiary where some hives are exposed to a long windsweep, while others are in a more protected position. Observation covering a period of years has shown that the latter winter much better than the former.

Nature will very often furnish natural windbreaks that are much superior to anything man can put up where there is nothing. A sidehill gradually slanting down from the north to the south, with shrubbery, fence, or trees on top, makes an ideal windbreak. Sometimes a location can be found where the hill on the windward side is in the form of a semicircle. Cases in point is the apiary shown on the next page, which is well protected by a hill. The small trees in the background and down among the hives help to break the violence of the wind. Such a location is ideal.

A good winter location is a cleared spot near the south edge of young timber over which the bees can fly in going to the fields. When the woods are made up of old forest trees it is too much of a good thing because the bees have to fly too high to get out.

Sometimes a spot can be found on level ground where there is a dense growth of young trees on the northwest, and an exposure on the south and east. (See cut top of page 775.) This is all right provided there is no windsweep from the South.

Portable Windbreaks

Sometimes no location can be found that provides any natural windbreaks. The only thing that can be made available at once is a high board fence. Experience in the author's case shows that it may be desirable to move the apiary on account of a failure of honey sources. For example, several farmers in the locality may suddenly take a notion to stop growing alsike or sweet clover and put in some other crop to give the soil a rest. On account of such contingencies fences should be made up of panels, each panel being held in place by means of braces reaching to the ground on both sides, the bottom ends of the braces being

Twelve-foot-fence windbreaks used by R. F. Holterman. The boards are nailed vertically to horizontal crosspieces nailed or bolted to the posts. This construction can be made up in panels so that the fence can be moved in sections if necessary.

nailed to stakes. (See cuts bottom of page 775 and top of page 776.) This construction not only enables one to "pull up stakes" literally but to move the whole apiary, windbreaks and all, at comparatively little expense. The panels of the fence, after being taken down, can be laid on a big truck and carried to the other location.

Even if there were no intention of moving, this construction is cheaper than fence posts that must be long enough to reach to the top of the fence and into the ground at least 2½ feet, and strong enough to withstand the heavy pressure of wind. Fence posts meeting these requirements are rather expensive. A simple brace of two ⅞-inch boards nailed together (see page 776) is very much cheaper, with, of course, the great advantage that the whole outfit can be moved to another yard if necessary.

It will be noted in the artificial windbreak that the boards are placed a slight distance apart. As a little of the blast of air filters between the boards it stops it from rushing upward so fast, and then diving downward as it will do with a solid construction.

Importance of Letting Bees Form a Winter Nest

What is meant by a "winter nest"? A space of empty brood-cells in one or more combs, such space approximating the form of a flattened sphere in an ordinary Langstroth brood-nest. These empty cells surrounded by sealed stores constitute the winter nest where bees cluster when conditions are ideal. As the stores are consumed, the number of empty cells increases. As a general thing, the cluster of bees will be located near the front of the hive and regularly over the entrance. As the stores are consumed the bees move upward and backward, but the cluster in no case extends over the sealed honey when the bees are permitted to arrange their brood nest.

Very often a well-meaning A B C scholar finds three or four combs in the center of the hive, having a space of empty cells as large as the hand spread out. He thinks this is all wrong and will remove the combs containing such spaces, and put in their place solid combs of honey. What has he done? He has compelled the bees to cluster upon sealed honey. The cluster is broken up into slabs approximately ⅜ inch thick, each slab of bees separated by approximately an inch of solid honey. Instead of having one solid cluster separated by only the midrib of the combs, he has made a series of clusters, each within itself trying to maintain its own body heat but at very great disadvantage. This is a serious mistake that is often made.

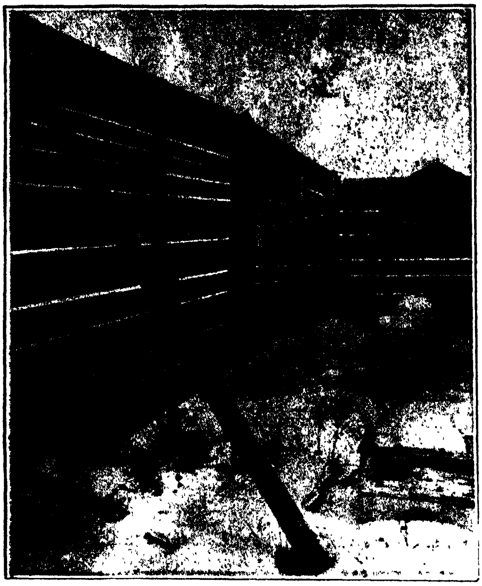
WINTERING IN CELLARS.—While the majority of beekeepers winter their

This apiary, belonging to Mr. Pritchard, is located at the bottom of a hill which forms a semicircle protecting the bees against the west, north, and east, leaving only a southeastern exposure. The thick growth of young trees on the top of the hill, together with the larger trees in the apiary inclosure, would make it impossible for any eddying currents to sweep down the hill and on the hives. The arrangement as a natural windbreak is ideal.

This apiary is located like that on page 774 in that it is screened from the north winds by trees. The low shrubbery helps also.

bees outdoors, yet there are localities where the outdoor method is either impracticable or impossible. The indoor or cellar plan is then imperative. To winter bees inside is much more difficult and unless one has had a large amount of experience he is liable to lose heavily. If one who is inexperienced will read these pages and follow instructions carefully, there is no reason why he can not succeed; but neither he nor any one else can winter indoors successfully if the climate is mild or the winter changeable from warm to cold. Cellar wintering is feasible

The interior of windbreak shown on next page. It is always desirable to have trees inside of an inclosure like this. In the first place, they furnish shade in the summer; and in the second place they lessen the force of the air currents that strike the side of the fence. The boards are separated slightly to allow the wind to filter through very slowly, thus preventing a blast from glancing upward and then downward.



Showing details of construction of an artificial windbreak. It will be noted that the windbreak is made up of panels, the boards of which are placed about an inch apart, each panel being held in place by means of braces on the outside and inside.. The arrangement makes it possible to move the windbreak as well as the the apiary itself. The panel is separated, the braces loosened, when the whole is laid on a truck.

and possible only where the winters are continuously and severely cold as has been already stated. In discussing methods for wintering bees outdoors, some principles have been given that apply to cellar wintering. However, bees while confined do not require more than 10 or 15 pounds of stores per colony, although it is an advantage to have more, because it is difficult to feed when set out. With a strong force of young bees, natural pollen, and good stores, one is well equipped to winter bees in the cellar, provided he has reasonable control of temperature and means for ventilation.

The author has been giving the matter of cellar wintering special consideration. He has traveled thousands of miles visiting some of the best beekeepers of the United States—especially those who wintered in cellars with little or no loss. After consulting them and government experts, he was particularly directed to one man, said to understand with special thoroughness the subject of indoor wintering. This man, Mr. David Running, Filion, Mich., has wintered bees for the last 25 or 30 years in a cellar of his own design, with a loss of less than one per cent. He is ex-president of the Michigan State Beekeepers' Association, and ex-president of the National Beekeepers' Association. As to wintering, he agrees in almost every

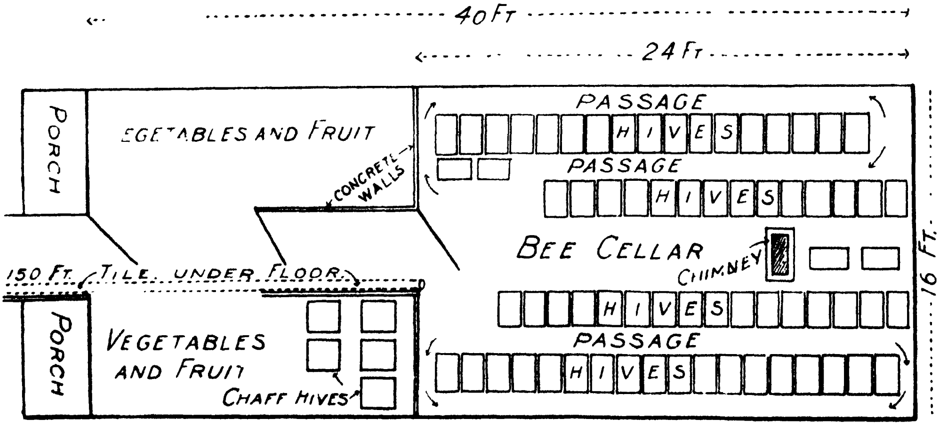


Fig. 1.—This is a diagram of the ground plan of the David Running bee-cellar which has wintered bees for the last 20 years with a loss of less than one per cent. The cellar proper is built in a sidehill. The bottom of the cellar is on a level with the ground in front. The walls are 6 inches thick, of concrete, with a concrete ceiling on top. Directly above the cellar is a concrete workshop and extracting-house. Between the ceiling of the cellar and the floor of this building above there is packing material of one foot of dry sawdust and one foot of air space, and then another set of joists covered with matched flooring. The cellar is capable of holding between 300 and 400 colonies. It will be noticed that there are three doors to shut out the outside cold. The hives are piled as shown in the diagram. The ventilator, or chimney has a 9 x 13 flue which extends clear up through the building above. The outer cellar is sometimes used for wintering bees in double-walled hives.

This is a bee-cellar belonging to Leonard Griggs, Flint, Mich. It is a type of an above ground cellar embodying the idea of David Running. The cellar proper extends into the ground about 3 feet. Then there is a three-foot embankment about 3 feet wide around the upper part of the cellar. The ceiling is covered with about 3 feet of sawdust. To keep the side embankments dry and frost-proof the roof extends entirely over the cellar and the embankment except at the front and Mr. Griggs thought it would be a good idea to cover this also. He has been uniformly successful in wintering bees in this cellar.

detail with that veteran authority, the late G. M. Doolittle. The fact that these two men came to precisely the same conclusions 30 years apart, the one without the knowledge of the other, makes the information now about to be given very important.

Both Running and Doolittle stress the value of young queens in late summer or early fall and young bees instead of old ones for good wintering.

Mr. Running specifies that the whole bee-cellar must be well protected from both cold and dampness. It is not enough, he says, that the whole of the cellar be underground and the ceiling on a level with the ground, unless between the ceiling and the roof there is three or four feet of sawdust. Many and many a good bee-cellar gives poor results because the temperature of the inside ceiling varies with the outside temperature. A cellar where frost during severely cold weather can be scraped off the ceiling is badly designed and can not be expected to give good results. Cellar must be absolutely dark.

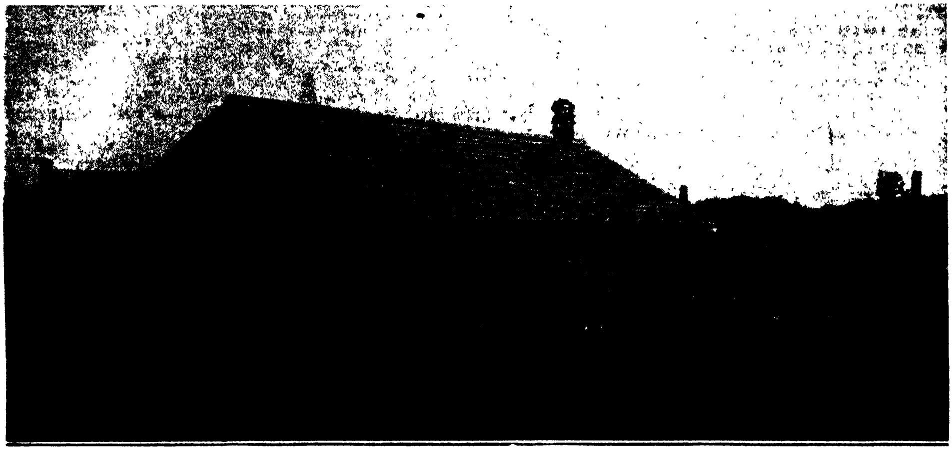
On account of the difficulty in obtaining proper drainage it is not essential, the same authority says, that the whole cellar be submerged 2½ to 3 feet below the general surface of the ground to get below the frost-line. In the great majority of cases the cellar will have to be partly above ground and partly below. But the important thing to remember is that the part above the general level must be protected by an embankment of three or four feet of dry earth, preferably dense clay. A loose or sandy soil must be roofed over to keep it dry. The ceiling of the cellar proper must be covered with at least three or four feet of dry earth or sawdust. Mr. Running has a workshop directly above his bee-cellar, making only a foot of sawdust above the cellar ceiling necessary. In order to keep the side embankments dry as well as the space over the cellar proper, it is important that, unless there is a heavy clay impervious to water, the roof itself should cover not only the width of the actual inclosure, but the embankment at the sides and ends. A wet or frozen embankment of sand or sandy loam means a low temperature in the cellar, and that is often fatal.

Regarding the amount of ventilation, our Michigan friend has been successful in the use of one ventilator, about 9 by 13 inches, in the back end of the bee-cellar, extending through the roof, and surmounted at the top by a chimney. This shaft should extend down to the level of the cellar floor. This is the outlet for foul air. The inlet consists of a sewer pipe running underground, opening into the front end of the cellar.

Although he has not used it, he believes it would be an advantage to have the inlet of this sub-earth ventilator continue in a vertical pipe to within a few inches of the ceiling. This would bring about a thorough circulation of air from top to bottom.

An electric fan can very often be used to good advantage, where electric current is available, to force fresh air into a cellar, or better, foul air out of the cellar.

The entrance to the Running cellar is effected by double (or, better, triple) doors through a narrow passageway leading from the level of the ground to the bottom of the cellar. If the cellar is half below the ground and half above, the entrance and exit are made easy by means of steps. If it is located under a side-hill, so that the bottom of the cellar is on a level with the ground in front, the conditions are ideal.



This cellar belongs to L. C. Gordon of Bellaire, Michigan. According to David Running's idea the roof should have extended over the side embankment. But these embankments are made up of sand that dries out very quickly; and in spite of the fact that it is not covered, it makes a good insulator. Mr. Gordon once told the author that in this 12 x 20-foot bee-cellar the preceding winter he wintered 151 colonies without the loss of a colony. The cellar has the ventilation recommended by Mr. Running.

Proper Temperature for the Cellar

The temperature of Mother Earth, according to Mr. Running, is about right for cellar wintering. Mother Earth varies all the way from 41 to 50 degrees. He said the best results in a cellar would be where the variation of the temperature is between 43 and 47 degrees.

While 45 degrees F. seems to be the point nearest right, according to most authorities, there are some who hold that it may be as high as 50, and others as low as 43 or even 40. Taking the two extremes, 45 seems to be the average. It is evident that in some cases a high temperature is better, and in others a low temperature. If the entrances are large, ⅞ inch deep by the full width of the hive, a higher temperature may be maintained than where the entrances are contracted to, say ⅜ inch deep by 6 inches wide. In the latter case the internal temperature of the hive itself, the colony being of the same strength, would be higher than where the entrance is ⅞ inch deep by the full width of the hive. The real consideration after all is the temperature of the cluster of bees. That temperature should be approximately 57 degrees. Large, powerful colonies would probably require a lower cellar temperature, other things being equal, than weak ones. Again, a cellar that has powerful colonies with contracted entrances should doubtless have a lower temperature; and the same colonies with a large entrance or bottoms removed entirely might have a temperature of 50 or even higher.

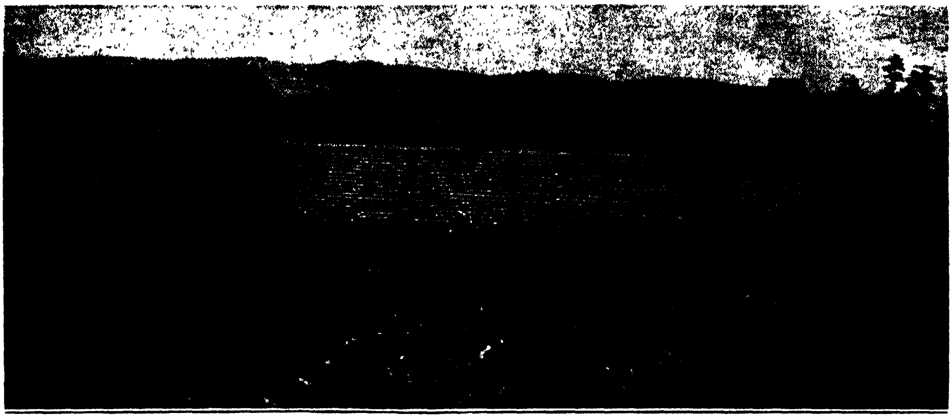
Taking all of these factors into consideration, it is easy to see how some, without knowing why, would favor a comparatively high temperature, and others a low one, and yet both would be right for their respective conditions. Coming back to the fundamental principle that the temperature of the cluster

should be, as nearly as possible, 57 degrees throughout the period of confinement, it will be easy to regulate the size of the entrance or the temperature of the cellar, or both, so that the temperature of the cluster shall be very near 57 degrees.

Unfortunately, not all the colonies of the cellar will be of the same strength. If the temperature is nearly right, say around 45, the internal temperature of individual clusters can be regulated by the size of the entrances.

To determine the temperature, it will be impracticable and entirely unnecessary to stick a thermometer into a cluster. For all practical purposes, if a thermometer placed on the bottom-board, inside of the entrance, shows a temperature of about 52, it may be surmised that the temperature of the cluster will be about 57. Let it be supposed, for example, that there are two small colonies in a certain cellar. The average temperature of the cellar is somewhere around 45. If there be shoved into the entrance of colonies of different strengths an ordinary dairy thermometer tested for accuracy, or even a common house thermometer (if it can be shoved into the entrance), it will be possible to determine in these colonies the temperature of the bottom-board. If the variation is not very great, and the temperature stands around 52 a few inches back from the entrance, it may be assumed that the cellar temperature is about right. But if it is found that one colony has a bottom temperature of 47 or 48, and another one a temperature of about 55 or 56, it is obvious that the entrance of the first named should be contracted to a point where the temperature will be about 52. The other entrances should be enlarged until the mercury in the thermometer drops down to the required point. In a word, the temperature of the cellar should be at a point that will give as nearly as possible the proper temperature of the cluster, and that is 57. (See Temperature.)

If, when one puts the bees into the cellar, he marks on each hive its relative strength, he will be able to determine the degree of contraction for each entrance; but before he determines the right contraction he should use thermometers in a few test colonies.



This cellar (7½ x 25) belongs to Peter Sowinski, of Bellaire, Mich. His home cellar (7 x 30) is not shown. Mr. Sowinski wintered 285 colonies in these two cellars without loss. The home cellar embodies all the ideas of David Running. The author went into this cellar at the time of his visit, and, notwithstanding the temperature was 80 degrees in the shade outside, it was down to 45 in the cellar. Mr. Sowinski keeps his vegetables, butter, eggs, and other foodstuffs in this cellar. The drinking water, kept in jugs here, seems to be as cold as ice. The scheme of ventilation was the same as Mr. Running's.

So far neither the question of food nor that of the age of the bees has been touched on. Mr. Running said that, of course, he would much prefer good sealed stores; for, when they are used, there is no bad spotting of the hives when the bees are taken from the cellar in the spring, even if they had been confined from four to five months. Though the bees will not winter as well on poor stores as on good, still if they are wintered in a properly constructed cellar, the amount of food consumed by the bees is so small that no serious consequences occur.

The same authority says that many times the beekeeper can not have young bees, and many times he will have to put up with inferior stores. But he is strongly of the opinion that if bee-cellars are built right—and that, of course, means proper drainage and protection—one can winter any kind of bees. When the cellars are not properly protected, good stores and young bees are almost a necessity.

Wintering in an Ordinary House Cellar

Wintering in an ordinary house cellar is practicable; but it should be perfectly dark and it should be understood that a house cellar is much more subject to variations of temperature, either on account of the presence of a furnace in the adjoining room, or because of the exposure of the walls above ground to outside temperature, which is always very variable. The author's experience has shown that where the temperature inside is variable —from 40 to 60—there must be a large amount of ventilation, especially at the higher points. Good results were secured with the temperature ranging between 55 and 60; but when it is as high as this there will be a loud roar from restless bees, unless there is a constant interchange of air. It is a little difficult to bring this about in an ordinary house cellar, unless one can use an electric fan so placed as to bring about a change of air. Where there are a few colonies—10 to 15—in a room 10 x 12, the ventilation is not hard to regulate, especially if the door leading from the bee-cellar into the furnace-room is left slightly ajar. It is put down as an axiom that 10 colonies in a house cellar will winter better than 50 or 75 colonies, provided the temperature does not go below 40. If the cellar is not frost-proof—that is, will not prevent vegetables from freezing—it will be a very poor place for bees. A cellar reeking with dampness is also bad, although bees have wintered well in house cellars where there was a great amount of dampness; but it was because there was a temperature not lower than 45.

E. G. Brown's upground cellar constructed by setting four fence posts about four feet into ground at the four corners of the proposed cellar. The portion of the posts above the ground is boarded up on the outside. The dirt on the inside is shoveled out, forming an embankment around the board fence. The whole is covered with a roof as shown. This is the simplest form of a bee cellar and the best where there is dense clay.

Stores

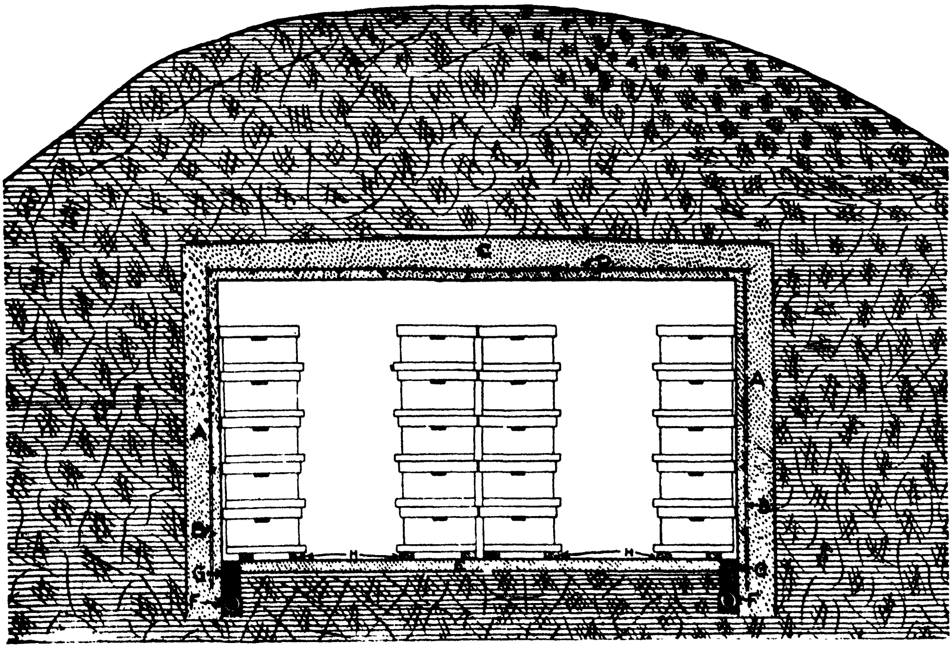
Usually a single brood-nest will have enough stores to carry the colony through winter in the cellar; but some beekeepers—notably Leonard Griggs, who is one of the most successful producers in Michigan—give to every colony they put into the cellar a half-depth super of natural stores, or a food-chamber. This is in addition to what the lower story happens to have. (See Food-chamber.)

How to Build a Bee-cellar

So far no specific directions have been given on how to build a cellar. (See cut next page and legend.) Where the clay is firm and will not cave in, sustaining walls are not necessary. But in most localities a wall or board siding is very essential. Concrete walls are probably cheapest in the end. Where the cellar is temporary or on rented land very good bee-cellars have been built by using cheap boarding nailed against wooden posts.

Mr. Brown (see page 780), Sioux City, Ia., makes four holes in the ground with a post auger. These holes are deep enough so that an ordinary fence-post will stick above the ground three or four feet. The boarding is then nailed outside of the posts above ground. He then gets inside of the inclosure and digs an oblong pit deep enough so that he will have about 6½ feet between the ceiling of the cellar and the bottom. The inside dirt is thrown outside of the wooden barricade. This leaves an embankment of four or five feet of earth. He uses no sustaining walls in the lower half of the cellar. A ceiling is then put on, and then a gable roof is made to cover the embankment as well as the cellar proper. On top of the ceiling and under the gable roof is put from three or four feet of sawdust.

From the general investigations that the author has been able to make, and from the results of his own experience, he comes to the conclusion that the ordinary bee-cellar should be relatively long with the entrance in one end. The temperature of Mother Earth in most localities where cellars are used is between 40 and 50 Fahr.—just about the right range to have inside a cellar. The walls next to Mother Earth become radiators of heat and cold because they draw from an enormous reservoir, so to speak. The larger the amount of wall surface exposed below ground, the more even the temperature in the cellar. A relatively long, narrow cellar, submerged five or six feet below ground, through which cold can not penetrate, gives the largest possible amount of wall and a temperature of approximately 45 degrees—just where it should be for good wintering in a cellar. The author's cellar is 12 feet wide by 60 feet long, by 6½ feet high inside, wholly submerged beneath the surface, with concrete walls, sides, ends, and ceiling. This cellar is covered with some four feet of clay closely packed. The cellar opens into the basement of a main warehouse building, from which ventilation is secured by means of an electric fan. Up through the ceiling and earth, at the back end, is an 8-inch sewer-pipe chimney through which the air is forced by the fan, where there is not a natural draft. During a very warm winter, the first year this cellar was tried, it gave excellent results in spite of the fact that



Cross-section of Root's bee-cellar showing two aisles and four long rows of hives. Two-by-fours (H) are placed on the cellar bottom as supports for the hives. The floor, walls, and ceiling of the cellar are of solid concrete, the ceiling and walls being reinforced with steel bars (B) and (D). The drainage-tile (F) is shown covered with cinders (G).

the temperature outside was around 60 and 65 degrees for many days.

It was also found that sudden changes of temperature have very little effect on the cellar. About Jan. 9 the mercury outside dropped over 40 degrees in 24 hours; yet this did not change the temperature of the cellar one degree. Not until spring did the temperature go above 50 degrees and then only a few times; 44 was the lowest mark registered, and this only three times. The average daily variation in the bee-cellar was less than 2 degrees and the greatest change in one day was 3 degrees.

Where the soil is not impervious to water there should be a roof over the three or four feet of dirt. In our Ohio soil the clay is impervious to water and no roof is used.

Sub-earth ventilators should be from four to six inches in diameter, made of glazed tile, about 100 feet long, and from four to six feet below the surface of the ground. The outer end is brought to the surface of the ground, and the inner opens near the bottom of the cellar. Cold air entering the ventilator is warmed in passing under ground to the cellar, and not only supplies the latter with pure air, but at the same time raises its temperature several degrees.

Sub-earth ventilators are not used to any great extent at this writing. The plan of using a furnace under the house, placing it in a room by itself adjoining the cellar, is preferable, provided that outdoor air is allowed to go into the furnace room from a door or window.

Arrangement of Hives in a Bee-cellar

The hives may be piled one on top of another in such a way that any one can be removed without disturbing more than the one or two above it. The reason for this will be apparent later. Strong colonies should be put in first and placed on a 2 x 4 scantling. On top of these may then be placed the weaker ones. This has the special advantage of having the heavy ones at the bottom and the light ones on top. The former, requiring a lower temperature, will be where it is cooler; and the latter, being weaker, will require a higher temperature, and will be where it is warmer. Some consider it essential to remove the bottom of the hives entirely. Others consider it good practice to have a deep space under the frames by raising the hive off the bottom in front and supporting it there by a couple of blocks. But some disastrous results in wintering seem to show that too much bottom ventilation is bad unless the cellar is kept at a temperature of about 60 degrees and thoroughly ventilated. The author uniformly secured the best results with a reasonably small entrance, or one about the size used during the fall or late spring. The larger the colony, of course, the larger the entrance that will be required. In the case of a strong, populous colony the entrance should be ⅜ inch deep by the full width of the hive. The colonies of medium strength should have the entrance reduced accordingly.

Inspecting the Bees During Midwinter and Dead Bees on the Cellar Bottom

Experience has proved that, when the temperature is maintained at 45 degrees, very little attention need be paid to the bees, especially in the fore part of the winter. But during the last month or two of confinement the bees require watching more carefully, for if they get to roaring many of them will be lost. It then becomes necessary to make frequent examination to determine the temperature and the quality of the air. It will also happen, perhaps, that a good many dead bees will be found on the cellar bottom. While this is not necessarily a cause for alarm, it is not as it should be. If the cellar and temperature are right there will be very few dead bees; but if they accumulate, their dead bodies should not be allowed to taint the cellar, but should be swept up perhaps every two or three weeks and removed.

A disposition to roar should be met by more ventilation, and at the same time the temperature should be reduced. If all the colonies in the cellar should become uneasy during midwinter it is evident that something must be done at once or the whole lot of bees will be lost. They ought not to become uneasy until late in the spring. If they can not be quieted by infusion of fresh air, it may be best to give the uneasy colonies a flight on the first warm day by setting them outdoors and letting them stay there for 24 hours or until they can clean themselves. Dysentery or diarrhea in the bee-cellar is generally the result of too much cold air or too high a temperature, either of which will induce too large a consumption of stores; and where bees are not able to void their feces, the intestines

become distended, resulting in purging. A colony so affected should be removed as soon as a warm day comes and given a flight, when it may be put back.

When to Put Bees in the Cellar, and When to Take Them Out

This is a question that depends entirely on locality. Most bees go into the cellar in the northern states between the middle of November and the middle of December; but usually it is advisable to have all bees in before Christmas. As to when the bees should be taken out of the cellar, authorities differ. Some set them out in March, and then put on winter cases. Others believe it is better policy to keep bees in late or until the last cold weather is past, and then set them out. The author advises taking the golden mean, waiting until the time natural pollen comes. But when bees are uneasy in the cellar it is advisable to set them out earlier than would be done otherwise.

Time of Day to Take Bees Out

The old plan for taking bees from a cellar in the spring was to wait until fairly settled warm weather had come, and then on some warm bright day all the colonies were removed at once. The difficulty with this method is that the bees are likely to become badly mixed. Some colonies will receive too many bees and some too few through drifting.

E. W. Alexander, in Gleanings in Bee Culture, page 286, Vol. XXXIV, gave a plan that overcomes this.

> First, get everything ready for a big job, and watch the weather closely, especially after a few nice days, for it is quite changeable at this time of the year. Then when the wind gets around in the east, and it commences to become overcast with heavy clouds, and has every appearance of bad weather for the morrow, we commence about sundown and carry out all our bees—yes, even if it takes not only all night but into the next day; and if it commences to rain before we are done, all the better, for we don't want any to try to fly until they have been out two or three days if we can help it. By this time they will have become nice and quiet; and when a fair day arrives they will commence to fly, only a few at a time, and get their location marked, so there will be no mixing up or robbing, because they all have their first fly together. Then when the day is over we find by examining the hives that nearly every one has apparently retained all its bees.

The plan here given avoids "drifting" on the part of the bees. (See Drifting.) When bees drift from one hive to another it means that the strong become stronger and the weak weaker. Moreover, there is danger of robbing. When bees are set out at two or three different times, those first set out, having marked their locations and having quieted down, are quite liable to rob those set out afterward, because the last lot of bees are more or less demoralized until they can mark their locations and recover from their excitement.

Shall the Colonies be Put Back on the Old Stands in the Spring?

After bees have been shut up in the cellar over winter they can be placed back on the old stand they formerly occupied or they can be put anywhere in the yard, or, in fact, anywhere on the premises. Bees, after long confinement, apparently lose all knowledge of their former location, and will stay anywhere they may be placed. If one finds it necessary or desirable to move his bees a short distance, it is a good plan to wait until they are taken out of the cellar the following spring, when they may be placed anywhere.

Carriers for Hives

A wheeled vehicle is not as good for moving bees in and out of a cellar as some sort of carrier, though a wheelbarrow does very well with a pneumatic tire. If the cellar steps are not too steep, a plank runway can be provided so that the load of bees can be delivered into the cellar itself.

Two men can easily carry as many as three hives in the manner shown on next page. Where the cellar is located some little distance from the apiary this is the most convenient method yet devised.

Some Things to Remember in Cellar Wintering

1. The temperature of the bee-cellar should be approximately 45 degrees. Whether it should be higher or lower will depend on the size of the colonies and the entrances of those colonies.

2. An excess of dampness in the cellar does no harm provided the temperature of the cellar is such as to make the temperature of the cluster approximately 57 degrees F.

3. A low temperature in the cellar, say 35 to 40 degrees, or any temperature at which the heat of the cluster is much above or below 57, with an excess of dampness, is a very bad condition.

4. Bees can be wintered in a cellar without much ventilation, provided the temperature of the individual clusters is approximately 57 degrees. With average-sized colonies and averaged-sized en-

Hive-carrier for carrying bees into a cellar.

trances, a constant temperature of about 45 degrees in the cellar will not require much ventilation, provided the size of the entrances is in proportion to the size of the colonies.

5. Ideal conditions for cellar wintering are the right cluster temperature, a slight amount of moisture, a moderate amount of ventilation, and absolute darkness.

6. A very bad combination is a constantly varying temperature that goes down nearly to the freezing point, and then rises to 55 or 60 degrees. Such frequent changes are very hard on the bees.

7. A high cellar temperature will require very much larger entrances, or possibly the removal of the bottom-boards entirely, leaving the whole bottom of the hive open. There are some cellars where the temperature can not be held down, and in such cases more ventilation is required as well as larger entrances.

8. Occasional disturbances by the beekeeper himself in the cellar do no harm; but these disturbances should be as few as possible, and with no jarring and as little noise as possible. No brighter light than a hand pocket electric lamp should be used. With this, one can easily make his way through the cellar, taking a glance at the entrances and also a glance at the thermometers in the entrances of some of the hives. A more durable and lasting light is an electric lamp attached to a full-sized battery. Small pocket batteries are usually short-lived.

9. When good colonies winter well the dead bees do not collect on the hive floors nor are they scattered over the cellar floor. The live bees remove the dead ones, leaving them on the cellar floor just below the entrances. If scattered all about, it is plain that they have flown from their hives and have not wintered well. Moreover, if there are several inches of dead bees on the cellar bottom in the spring, the owner of that cellar ought to investigate and ascertain the trouble. No matter if he does bring his colonies through alive, it could hardly be said that he is wintering his bees successfully. An ideal cellar is one that will bring the colonies through the winter in practically the same strength as when they went into winter quarters. No colony should lose more than one-sixth of its bees, and well-wintered colonies will have much less loss than this—in some cases as low as 100 bees.

10. Honeydew, unsealed aster honey, molasses, or syrup from brown sugar, make a poor feed for indoor wintering. It is much better to have a good honey, well ripened, or syrup made of white granulated sugar.

11. Pollen in the combs does no harm. Indeed, it is an advantage to have some of it ready for the next spring after the bees are set out. The old theory that an excess of pollen in the combs is the cause

of dysentery is now an exploded myth. (See Pollen.)

12. Shutting bees in the hive with wire cloth, or closing the entrance in any way, is usually attended with disaster.

13. Bees can be wintered in a house cellar provided it is dark and not too much variation of temperature. The trouble with most house or vegetable cellars is that they become too warm or too cold. This makes it necessary for the beekeeper to enter the cellar, often opening and closing the cellar windows at night. The disturbance is a bad thing, and the variation of temperature is still worse.

14. A cellar wholly under ground and frost-proof is much safer than the average house cellar.

15. When one has from 100 to 300 or more colonies and the winters are so cold that there are many days of zero temperature, especially if the locality is subject to high winds, it would be well to build a special bee-repository underground, large enough to accommodate as many colonies as one would be likely to own. The mistake should not be made of building it too small. It should be constructed on the lines indicated by David Running, as specified in previous pages. Its shape should be long and narrow and wholly underground. That means that the roof should either be below the frost line by three or four feet, or that the portion of the repository above ground should be covered by an embankment of three or four feet for the sides above ground and three or four feet on top. Err on the side of having the repository covered too deep rather than not deep enough. If the earth covering it is not a pure yellow clay that is impervious to water, it is better to make a special roof over it. Sand or gravel should always be covered to keep it from freezing.

16. An electric fan can very often be used to good advantage in ventilating a bee-cellar. Where a cellar under a dwelling house becomes too warm, an electric fan can be stationed in such a way as to force air from outdoors into the room. Bees will stand a comparatively high temperature provided the air is fresh and sweet.

17. Last, but by no means least important, there should be a young queen and young bees. A young queen should be introduced in August. A young queen will lay eggs where an old one will fail to do so. Eggs and brood in August and September mean plenty of young bees to go into winter.

How and What to Feed Bees During Midwinter

It is generally advisable to avoid feeding syrup during midwinter, either in the cellar or outdoors. If a colony will run out of stores before spring, then thick syrup, two and a half parts of sugar to one of water, may be given all at one feeding. A better winter food next to combs of sealed stores is hard candy as mentioned under the head of Candy elsewhere, provided it is made right. Plates or blocks of this candy can be laid on top of the frames. If the candy has not been scorched in making, the bees will cluster up under it and winter on it, even though there is not an ounce of stores in the combs themselves. But as it is a nice art to make hard candy that is just right, and as it is advisable, when possible, to avoid feeding sugar syrup, beekeepers should always have in reserve a sufficient number of combs of good honey saved out from the summer crop. When it is discovered that the colony is short, one or more of these combs can be inserted in place of the empty ones.

A much better plan yet is to reserve from the season's crop of honey as many shallow extracting-supers of good honey as there are colonies in the apiary. (See Food-chamber.) It may be argued that the honey in these supers can be sold for considerably more than it would cost to replace the deficiency in the colony with sugar syrup. This is not true.

For a further discussion of this question, see Feeding and Feeders and Food Chamber.

Do Bees Hibernate?

The quiescent state, or sleep, into which bees enter when the wintering conditions are ideal, has been several times mentioned. In this period the bees seem merely to exist. With no activity, the consumption of stores is very light.

As shown under Temperature, particularly the temperature of the winter cluster during winter, bees are the quietest when the thermometer is about 57° F. If it goes below 57°, the bees, instead of clustering, become active, and in the manner explained under Temperature they raise the heat of the cluster sometimes almost to the brood-rearing point. When, therefore, the temperature of the

cluster is either below or above 57° F., the bees are in anything but a state of sleep, or what some have called semi-hibernation. Strictly speaking, bees do not hibernate, and perhaps do not even enter into the condition called semi-hibernation when they are the quietest. It all depends on what is meant by that term. But there are some interesting facts showing that bees can for a short time stand low temperatures, and revive like ants and flies that are true hibernators. In the discussion which follows, however, one must not be misled. Yet it is evident that nature has provided means by which bees can stand the temperature of freezing, or below, for a short time. In order that the reader may understand what hibernation really is, a few facts should be presented.

Hibernation of bees was exploited nearly 50 years ago, when it was generally decided and rightly too, that bees do not hibernate in the ordinary sense of the term (see American Bee Journal for 1885). But they do enter a quiescent state when the temperature has been lowered; and this state is somewhat analagous to the torpor experienced by some animals in a state of true hibernation, during which no food is taken, and respiration is considerably reduced. Dr. Marshall Hall has stated that "respiration is inversely as the degree of irritability of the muscular fiber." If the respiration is reduced without this irritability being increased, death results from asphyxia. Hibernation is usually induced by cold, and the animal under its influence attains nearly the temperature of the surrounding atmosphere, yet its capacity to endure cold is limited and varies with the animal. Some animals bury themselves in holes, like snakes and frogs; others, like the bear, crawl under a pile of leaves and brush where they are still further covered with snow. Thus buried they will go all winter without food or water; but there is a waste of tissue. Fish may be incased in ice and still live. A lively frog may be dropped into a pail of water four or five inches deep, and exposed to a freezing temperature. Indeed, there may be a thin coating of ice formed over the animal. The next morning that frog, though stiff and cold, can be warmed up into activity; but to freeze solid will kill the creature.

Flies, as is well known, will secrete themselves in window-frames and other hiding places, subject to cold atmosphere for weeks at a time, and yet revive on exposure to warmth. As is well known, also, ants have been repeatedly dug out of logs, frozen solid—in fact, fairly enveloped in frost; yet on exposure to warmth they will revive. Some hibernators can endure a freezing temperature, while others, like the bear, woodchuck, and the like, can not. Other very interesting incidents may be taken from natural history; but the purpose of this article is to consider whether bees go into a quiescent state that approaches hibernation, in which there is low respiration and a small consumpton of stores.

Two or three years ago the author put a number of cages of bees with some queens into a refrigerator, laying the cages down on cakes of ice. The bees were chilled to absolute stiffness. Every day a cage was taken out and each time the bees would revive, including the queen. This plan was continued for several days, and yet the bees would "come to" each time.

The strange part of it was that the queens went on laying normally when put back into the hives, instead of laying drone eggs as expected. Just what was the temperature to which these bees were subjected can not be told, but probably below 40° and above 35°, for the doors of the refrigerator were frequently opened and the ice was constantly melting.

During one winter, when a very cold snap came on — the temperature going down to zero—the author put out some cages of bees, exposing them to the cold wind, which was then blowing a good gale, when the temperature was 5 above zero. It was expected that the bees possibly might be able to survive the shock for a number of hours, and yet revive; but 20 minutes of zero temperature was sufficient to kill them outright. If the bees had been gradually acclimatized to the cold, first being subjected to 40°, then to 35°, and gradually down to the zero point, they would possibly have withstood the shock for a longer time.

When the weather warmed up a little several cages of bees were taken and buried in the snow, with a thermometer so that the absolute temperature might be known. A cage of bees was taken about every two or three hours, and it

was found that they could be revived without difficulty; but at the end of 24 hours the bees, when they "came to," seemed somewhat the worse for the experience. The temperature in the snow played around the 32° mark. But the experiments conducted during the summer in an ice refrigerator would seem to show that bees might stand a temperature of 38° for a number of days.

Bees on the outside of the ball or cluster, in an outdoor-wintered colony, will often be chilled stiff while those inside have almost a blood temperature. During very severe weather the outside bees may be gradually replaced by those within the cluster, for bees are in constant movement. Experiments show that a starved bee will not stand as much cold as one that is well filled. Beekeepers who have had any experience in wintering outdoors know how repeatedly they have taken clusters of bees that seemed to be frozen stiff, yet when warmed up before a good fire would revive and appear as lively as ever.

In view of the experiments thus far recorded it would appear that bees might be able to stand a temperature of 40°, or slightly below that, for a number of days; but if a warm spell does not come within a week, or less, those bees in their chilled condition may starve to death. But if it warms up, the cluster will unfold and the bees take food, and so be ready for another "freeze." The author has repeatedly seen clusters of bees, after a zero spell lasting a couple of weeks, that were dead; but the honey had been eaten from all around them within a radius of an inch or more. If a zero spell of weather continues more than a week or ten days, some of the weaker colonies will be found in the spring frozen to death.

If the bee were a true hibernator it would save the beekeepers of the world millions of dollars, because then all that would be necessary would be to establish a sort of cold-storage plant, where the climate was open or mild, and put the bees away for winter. In cold climates it would not be necessary to have cold-storage plants. The bees could be placed outdoors without protection, and left all winter; yes, they could easily be put on dry combs. Like the ants and flies, they would remain in a dormant state; and when warm weather came on they would revive and resume their former activity. But, unfortunately, bees are not that kind of insect. That they will go into a quiescent state, or a kind of suspended animation, at a temperature of 57 degrees Fahr., has been clearly proven. During that period they consume the minimum stores.

WIRING FOUNDATION.—See Comb Foundation.

WORKER COMBS.—See Combs.

WOMEN AS BEEKEEPERS. — See Beekeeping for Women.

X Y Z

XENOPHON.—A Greek historian and general who refers to poisonous honey. (See Poisonous Honey.)

XYLOCOPA.—To this genus belong the carpenter bees, among which are the largest bees in the world. They are so called because they excavate with their powerful jaws tunnels a foot in length in solid wood. The cells are about an inch long, and are separated by partitions made of small chips cemented together in a spiral. The eggs are laid on masses of pollen, moistened with honey, the pollen masses being about the size of a bean. A common species in the eastern United States is *X. virginica.*

YEASTS IN HONEY.—It is well known that alcoholic fermentation is caused chiefly by various species and forms of yeasts, and that alcoholic fermentation precedes acetic fermentation, as in the production of vinegar. (See Vinegar.) Since fermentation of honey and the production of a sour taste is all too common in honeys under certain conditions, there has been considerable interest in the species of yeasts found in honey as the first cause of this spoilage of the beekeepers' product. (See Honey, Spoilage of.) It is well known that honey is a mild disinfectant and that minute organisms which get into it accidentally are usually quickly killed, and one would presume that this would happen to yeasts which might enter honey from the air or otherwise. (See Honey Antiseptic.) There are, however, certain conditions in honey, when the disinfecting value of this product is reduced to the point where yeasts are not only permitted to remain alive but in which they can grow and cause spoilage.

It has long been known that unripe honeys ferment, due to their higher water content, and in general it is in such honeys that fermentation is most often noticed. There are, however, many cases where apparently well-ripened honeys show fermentation, usually not so quickly as do unripe honeys. This is rather easily explained by certain phenomena which occur during the granulation of honey. When honey granulates, it is only the dextrose which forms crystals, the other sugars still remaining in solution, this solution forming a thin film about the crystalline particles of dextrose. When dextrose forms crystals, one molecule of water is incorporated in the crystal with the sugar, this water amounting in weight to just ten per cent of the actual weight of the dextrose sugar. The crystal of dextrose is, therefore, in a sense more concentrated as to water content than the original honey solution. This means that the original water of the honey in which the dextrose was formerly dissolved is now released to assist in forming the solution of levulose, sucrose, and other materials which enter into the composition of honey, and this condition may result in the film of this solution having a water content as high as 32 per cent, which is far in excess of the water content of unripened honey in most cases. This condition explains why it is that granulated honeys ferment more commonly than honeys that remain in liquid condition. With a high water content, such as occurs in granulated honeys, yeasts can thrive, and they often do great damage to stored honey. It is well known to extensive handlers of honey that greater evidences of fermentation are to be expected in honeys carried over to a second year than in honey of the current year, and some dealers now find it necessary to refuse to purchase honeys of the previous year. If one checks up on these troubles, it is found that it is the granulated honeys which cause the greatest trouble and loss. (See Honey, Science of, and Science of Granulation, page 366.)

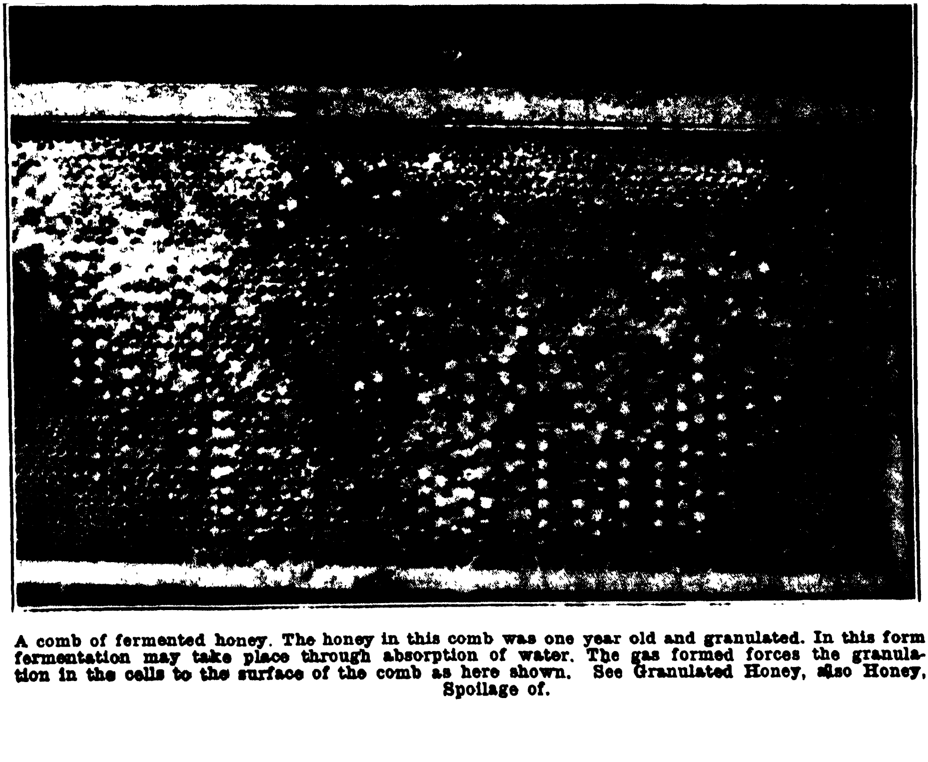
Nectar Yeasts

Since in many species of plants the nectaries are exposed to the air and are frequently visited by insects, it is not surprising that yeasts occur in nectar,

which should form a good medium for their growth. In 1917 Gruss discovered a peculiar yeast which developed in the form of a cross and which later proved to be a new genus and species, and last observers have also found such yeasts in nectar. It was later found also that the peculiar cross form was due to a lack of nitrogenous food in the nectar, and that this form could be transformed to the usual yeast form by providing more nitrogenous material and a higher sugar concentration. A Swiss worker, Schollhorn, found that yeasts distributed through the visits of bees differ from those entering nectaries with dust particles. It has also been found that in flowers with protected nectaries and in flowers in dust-free air, as in high elevations, nectar is sterile. If yeasts are present in nectar, one might expect that they would be carried to the hive with the nectar and might enter honey. In all probability, this is not a common source of trouble in honey fermentation.

Water Absorbed by Honey

Levulose, which is one of the chief sugars of honey, has the property of absorbing moisture from the atmosphere or from any moist material coming into contact with it. (See Honey Antiseptic, page 400. Note particularly what Browne says.) It is, then, not surprising that honey absorbs moisture if allowed to remain in moist air. Fabian has studied the amount of water which can thus be absorbed under extreme conditions of humidity and finds that extracted honey may increase in weight almost 33 per cent by the absorption of water from the air. This is, however, far in excess of what would occur under the usual conditions of honey storage. Similarly, Fabian determined the loss of weight in comb honey which might occur when stored in an extremely dry place and found that there may be an average decrease of over 7½ per cent over a period of seven years under such conditions. When this comb honey that had been exposed for such a long period to extremely dry conditions was then placed under conditions of excessive moisture in the air it quickly regained its original weight (in ten days or less), and afterward came to exceed its original weight by over 3 per cent. Comb honey thus first dried and then exposed to moisture at a higher temperature, came to weigh 15 per cent more than the original weight. It is thus seen that both ex-



A comb of fermented honey. The honey in this comb was one year old and granulated. In this form fermentation may take place through absorption of water. The gas formed forces the granulation in the cells to the surface of the comb as here shown. See Granulated Honey, also Honey, Spoilage of.

tracted honey and comb honey may become a suitable medium for the growth of yeasts if allowed to absorb moisture from the air, hence the usual advice to keep honey in a dry place.

Failure of Honeys to Mix Readily

Another factor which may at times have an influence on fermentation and the growth of yeasts is the peculiarity of honeys of different densities not to mix readily. Beekeepers who have extracted honeys of different densities all in one day's work and have run them into one tank have probably noticed that by the next morning the thin honey will come to the top and the heavy or well-ripened honey will settle to the bottom of the tank. One might naturally suppose that the mixing of honeys by putting them together in one tank would cause the entire mass to be of the same density, but this appears not to be the case. When honey is stored in a large tank it is highly probable that the thin honey will be at the top, giving a medium more favorable for the growth of yeasts at the top of the tank.

Yeasts Causing Honey Fermentation

Two recent studies of honey fermentation have been made by Fabian, of the Michigan State College, and by Marvin, of the University of Wisconsin. The results are similar in general, in that both authors find that yeasts of the genus Zygosaccharomyces are responsible for the trouble. Marvin states that he has found five strains of these yeasts in fermenting honey, but does not name them, while Fabian lists three previously known species and describes a new species of this genus. Fabian also finds a new species of Torula capable of fermenting honey. All these yeasts produce spores which increase their resistance to drying in honey. All five species agree in being able to ferment levulose and dextrose, and three of them ferment sucrose (cane sugar). To ferment sucrose, a yeast must contain the enzyme invertase, which is apparently absent from the two yeast species. All the species produce alcohol, which is a first step in the fermentation to acetic acid. It then appears that the fermentation of honey is caused by yeasts of peculiar forms, rather characteristic of this activity, although some of the species have been found causing fermentation in other products, such as soya in Japan in the case of one species.

Conditions Favorable to the Growth of Yeasts in Honey

Too high a water content in honey is a well-recognized source of trouble from fermentation, and Fabian finds that in general a water content of more than 21 per cent is favorable to growth of yeasts. However, in many cases, especially in granulated honeys, fermentation occurs with relatively low water content. Storage of honey in moist places, especially with high temperatures greatly increases the absorption of moisture to the point where the osmotic pressure of the honey is reduced to the point at which growth of yeasts can occur. It appears that in many cases yeasts remain inactive in honeys for a considerable time without causing fermentation, but that they begin growth as soon as the water content of any part, especially the upper surface, is increased. In the case of well-ripened honeys, absorption of moisture may take place slowly, but if the honey is promptly put on the market and used by the consumer, no damage from fermentation is noticed. In the case of honeys held over a second year the danger of damage from fermentation is thus greatly increased, and it is well known to honey dealers that fermentation is common in older honeys. According to Marvin, heating of honey to 160° F. destroys the yeasts and thus prevents fermentation, provided the honey is thereafter protected against further contamination from yeasts. This temperature is often reached in bottling honey, but it is generally recognized by observant beekeepers and bottlers that it is rare that large quantities of honey are heated to this temperature without some damage to the flavor and color of the honey.

Extent of Fermentation; Thorough Ripening Not a Preventive

While beekeepers generally seem to be of the opinion that well-ripened honey does not ferment, at the same time reports come from all parts of the country of losses from this phenomenon. As has been stated previously, this is more common in honeys held for some months or until the second season. Data obtained by Pugh from Canadian sources show a surprisingly high per cent of fermented honeys after being held for some months, a figure which would run into thousands of dollars annually if honeys were not sold promptly. It appears to be an en-

tirely erroneous assumption that thorough ripening is a certain preventive of fermentation, and that fermentation is evidence that unripe honey has been extracted. Neither can granulation be accepted as a test of the degree of ripeness or of the tendency to fermentation, since the very fact that granulation has occurred tends to make conditions more favorable for fermentation. Not only must honey be well ripened before extracting, but the utmost care must be exercised to prevent the absorption of water from the atmosphere after extracting, either in open tanks or in closed cans. The advice usually given that honey must be kept in a dry place must be emphasized, and it appears that a cool but thoroughly dry place is preferable to a warm location, since absorption of moisture takes place much more readily at higher temperatures. (See Honey, Spoilage of, page 489, second column). There is, however, more probability that a warm place will have a low relative humidity than a cooler one. The safest means of preventing fermentation after extraction seems to be to keep the honey under conditions which will almost tend to dry it up. From the evidence at hand, it appears that far more damage comes from keeping honey in moist places than from extracting too green.

The conclusion seems to be that yeasts which may cause fermentation may either enter honey after extracting or may be present in it from an early stage of the ripening. If for any reason additional moisture enters the honey, these yeasts may begin to grow and cause damage to the honey. The yeasts appear to be less dehydrated than are many bacteria which are destroyed by the action of the levulose in honey, and for that reason they constitute a distinct menace to the beekeeper.

YELLOW POPLAR.—See Tulip Tree.

YELLOW SWEET CLOVER. — See Sweet Clover.

ZINC, PERFORATED.—See Drones, Extracted Honey, and Swarming.

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